Georgia Emergency Medical Services for Children

Pediatric Life Support

Dedication

Forrest Adair III has devoted much of his life to meeting the health care needs of children—much like his grandfather, Forrest Adair Sr., who founded Atlanta's Scottish Rite Hospital for Crippled Children in 1915. In 1998, Scottish Rite Children's Medical Center merged with Egleston Children's Health Care System, a teaching and research pediatric institution located on the campus of Atlanta's Emory University. Scottish Rite and Egleston now work together as a unified health care system with one mission—to provide children with the highest quality pediatric care now and in the future.

In keeping with his family's long-standing vision, Forrest Adair III and his wife, Mable, ore funding the "Pre-Hospital Pediatric Life Support" program, a statewide educational seminar that teaches firefighters, emergency medical technicians and paramedics the "how-to" of pediatric trauma and transport. The second edition of the "Pre-Hospital Pediatric Life Support" provider manual is the basis for this continuing education program.

This book is dedicated to the family of Forrest Adair III. We are deeply grateful to the members of the Adair family for their continued support of Egleston Scottish Rite Children's Health Care System, as well as their support of the publication of this manual.

Joseph E. Simon, M.D.

Preface

It's Saturday morning. You and your partner are awakened by that all too familiar bell and dispatched to a person who is unconscious. Five minutes later you arrive at the location, arms filled with equipment. On entering the house, hysterical family members hastily direct you into a bedroom where you find a 5-month-old infant—cyanotic and gasping for breath. Your adrenaline surges, not only because of the strong emotions evoked by a sick child but also because the medical skills required in this situation are not as familiar to you as those demanded by other, more frequently encountered situations.

Only between *5* percent and 10 percent of EMS runs involve children. Only 1 percent of all EMS runs involve the use of pediatric advanced life support techniques. Not surprisingly, therefore, an EMT faced with the above situation will often feel very insecure. Medical expertise is heavily dependent on experience. When experience is lacking, training must compensate. That is what *Pre-Hospital Pediatric Life Support* is all about. The goal of this text is to help EMTs feel more at ease and confident when dealing with sick infants and children.

A child is not just a "little adult" for whom a smaller laryngoscope blade and drug dosages calculated according to weight will suffice. Children are different, but not necessarily more complex. For example, though a child may not be able to verbally communicate as effectively as an adult, her general appearance will "communicate" a truer picture of the degree of illness or injury than the general appearance of the adult. It simply isn't part of a 3-year-old child's repertoire to put on a "song and dance routine" to obtain sympathy or get even with a spouse!

The box below describes a few demographics of pediatric pre-hospital care. The data indicates that trauma, seizures, and respiratory distress account for the large majority of pediatric calls. Of particular note is that almost 70 percent of pediatric EMS calls involve infants and children less than 6 years of age. Infants and young children require a different overall approach from medical professionals than that which is required by older patients. This text will emphasize the care of infants and small children.

DEMOGRAPHICS OF PEDIATRIC PRE-HOSPITAL CARE				
Medical Condition			**Management**	
Trauma	54%		Evaluation only	34%
Seizures	9%		BLS*	40%
Ingestion/overdose	7%		ALS – simple*	11%
Respiratory distress	5%		ALS – complex*	5%
Altered mental status	4%			
Cardiopulmonary arrest	1%			
Other	20%			
Age Group				
Less than 1 year	18%			
1 to 5 years	49%			
6 to 12 years	33%			

Modified from Tsai A, and Kallsen G: Epidemiology of pediatric pre-hospital care, Ann Emerg Med 16:284,1987.
*BLS, basic life support; ALS – simple, advanced life support plus ECG monitoring or oral or rectal medications; ALS – complex, advanced life support techniques beyond those involved in ALS – simple.

The driving force behind the rapid development of EMS in the United States during the 1970s was the recognition that the high rate of mortality from sudden cardiac death in the adult population could be reduced through the prompt delivery of emergency medical care by pre-hospital providers. Accordingly, EMS systems were developed with the adult cardiac victim in mind. The 1980s brought forth the concept of *trauma care*. EMS systems were, therefore, revamped to deal with the special needs of the trauma victim. Finally, the special pre-hospital care needs of our children must be addressed. The diversity of EMS calls requires that EMTs be "multispecialists." Unlike many hospital personnel who have the luxury of simplifying their work through specialization, the EMT must be an expert in all aspects of emergency stabilization, including the stabilization of the pediatric patient.

A word about syntax and terminology

To avoid awkward syntax such as "he or she" or "him/her" this text uses masculine pronouns to refer to EMTs and feminine pronouns to refer to patients and one parent through about half of the text; in the other half the gender assignments are reversed. Finally, the term EMT is used to include all pre-hospital care personnel, both basic and advanced.

Joseph E. Simon

Acknowledgment
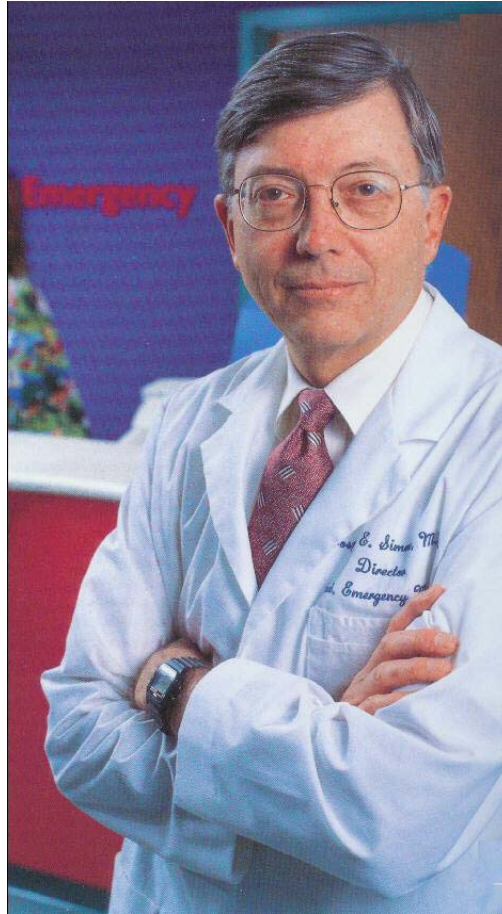
It is my honor and privilege to write this dedication to one of the most devoted, compassionate individuals in pediatric care, Dr. Joseph Simon. Dr. Simon has been influential in pre-hospital pediatric education for many years. His selfless contributions range from patient care to educational development, with many contributions in between. It has not been uncommon for Dr. Simon to be seen in a Pediatric Life Support class, working with pre-hospital providers on understanding breath sounds, or perfecting skills.

In a time full of budget cuts and continual training/educational needs, Dr. Simon offers his PLS manual through today's technology so that all may benefit from the expertise and education provided. Throughout the many years Dr. Simon has had only one goal, to offer consistent, knowledgeable, efficient care to the pediatric population across the health care profession, we thank you for your contributions and dedication to the future and to our children.

Kelly Buddenhagen, Project Coordinator
Georgia Emergency Medical Services for Children

Contents

Chapter 1

Pediatric Assessment

OBJECTIVES

1. Compare/contrast the four keys of an adequate pediatric patient assessment with those of an adequate adult assessment, including a comparison of the parameters assessed with each and the normal findings for each parameter.

2. Given a list of assessment parameters, separately select those that are least and most useful in a pediatric assessment and identify those that best indicate patient status with respect to the primary survey.

3. Given a patient scenario with findings from an assessment of a child's general appearance, determine the degree of severity of the scenario presented.

4. Given a list of statements regarding the general appearance of pediatric patients in various age groups, determine for each statement whether it is true or false.

5. Describe or recognize from a list of statements for each age group the expected response of a child toward her parents, her caregiver and strangers.

6. Given a patient scenario in which the child actively resists portions of your examination, list or select from a list the appropriate alternatives to successfully examine the child.

7. Given a list of statements regarding the assessment of blood pressure in pediatric patients of various age groups, tell whether each statement is true or false.

PEDIATRIC ASSESSMENT

Children are different! Nowhere is this fact better illustrated than in their reactions to an examination by a health care professional. Unlike the adult who is usually reassured by the arrival of an EMT team, the older infant or child is most likely to respond to a stranger with fear and agitation, particularly if the stranger is touching her, coming between her and other family members, removing her clothing, and "suffocating" her with a mysterious green mask. (How would you react if a stranger six times your size suddenly approached you and started to take off your clothes?)

There are four keys to making an accurate assessment of a pediatric patient. They are as follows:

1. Critically evaluating the patient's "general appearance" from a distance before approaching the child or infant to make more specific observations;
2. Varying one's approach in accordance with the age of the infant or child;
3. Focusing on breath sounds, respiratory efforts and peripheral circulatory signs when evaluating a pediatric patient's airway, breathing and circulation (ABCD);
4. Carefully observing the child's environment, including the behavior of various family members.

A discussion of each of these keys follows.

GENERAL APPEARANCE

The single most important parameter when assessing an infant's or child's severity of illness or injury is her general appearance; that is, her alertness, spontaneous movements, the quality of her cry or speech, her eye contact with you or her parent, her distractibility and consolability, her breathing efforts and her color (Table 1-1). General appearance is best assessed from a distance, with the child in the parent's arms. Attempts by the parent or other family members to distract and console the infant or child will provide useful information. This "assessment from a distance" is necessary because of the dramatic influence a stranger may have on the appearance of the child, particularly a uniformed stranger who is touching and examining the child. In particular, an aggressive, immediate hands-on approach to a pediatric patient can produce fear and anxiety resulting in a crying, thrashing patient. As described later in the text, this could obscure or alter one's evaluation of factors such as fontanel tension, respiratory rate, airway patency and level of consciousness. A child who is "assessed from a distance" to be smiling, moving spontaneously and reaching for a toy is not a medical emergency. (Note: This does not mean that the child should not be transported, but rather that aggressive intervention such as an IV infusion, oxygen or a transport with "lights and siren" are probably not indicated.) Conversely, the infant or child who is very lethargic, does not notice the EMT arrive on the scene, does not react or reach for a toy or does not cry lustily is at least moderately ill and may need both stabilizing procedures and rapid transport.

Two factors make general appearance a reliable means of assessing a pediatric patient. First, hidden emergency conditions are more unusual in children than in adults. The kinds of emergency conditions children experience, such as croup, meningitis and head injury, tend to affect the child's behavior both early in their course and in a predictable fashion. Adults, on the other hand, frequently suffer from

Table 1 – 1   COMPONENTS OF GENERAL APPEARANCE

Alertness	How responsive and perceptive is the child to the presence of a stranger or other aspects of her environment
Distractibility	How readily does a person, object or sound draw the child's attention? For example, to draw attention to a toy from a child who at first appears disinterested in her surroundings is a positive sign
Consolability	Can a distressed child be comforted? For example, to stop a child from crying by speaking softly to her or offering a pacifier or a toy is an encouraging sign.
Speech/cry	Is the child's speech/cry strong and spontaneous? Weak and muffled? Hoarse? Absent unless stimulated? Absent altogether?
Spontaneous activity	Does the child appear flaccid? Do the extremities move only in response to stimuli, or are there spontaneous movements?
Color	Is there pallor, a flushed appearance, cyanosis or mottling? Does the skin coloring of the trunk differ from that of the extremities?
Respiratory efforts	Are there intercostals, supraclavicular or suprasternal retractions in the resting state? Nasal flaring is also an indicator of respiratory difficulty.
Eye contact	Does the child appear to gaze aimlessly, or does she maintain eye contact with objects or people? Even very small infants will, when well, preferentially fix their gaze on a face as opposed to other objects.

emergency conditions such as angina-cardiac pain that may be severe and even life-threatening, but that may have subsided by the time the rescue squad arrives, resulting in a benign general appearance of the patient at the time of transport. Two notable exceptions to the reliability of general appearance in pediatric assessment are the near-miss SIDS infant and the child who has just ingested a toxic substance. These patients may appear well despite their emergent condition. However, they will probably require no more from pre-hospital care providers than rapid transport.

The second reason that general appearance is so reliable in children is that there is minimal psychological overlay to their behavior. They will, therefore, usually behave in a way consistent with how they truly feel. In contrast, denial or hysteria will often motivate the adult patient to present a general appearance that suggests lesser or greater ill feeling than she is truly experiencing. Indeed, EMTs must frequently deal with adult patients who appear more driven by the desire to win an academy award nomination for their performance than by the severity of their medical condition.

In summary, general appearance is one of the major keys to properly assessing the pediatric patient. This alone, without any additional information derived from a physical examination, will almost always enable the EMT to classify the pediatric patient as either critical or stable for transport.

AGE-RELATED EVALUATION

Not only do children respond differently than adults, but children of one age react differently than

children of another age. Some of these key differences and their implications for those performing medical assessments on children are discussed below.

BIRTH TO 6 MONTHS

Characteristics. These infants are not yet old enough to be frightened by the approach of a stranger. When healthy, they have a lusty cry. When fully alert, they are constantly moving, lifting their arms and Legs, turning their heads. (Medical students frequently call them "human windmills.") The younger ones are generally easily consoled with a pacifier. The older ones may be easily distracted by a light or repetitive noise. They have strong grasping and sucking reflexes. If they are in an active state, their breathing efforts are shallow and difficult to see. When they are quiet, their breathing might, at first, appear labored because infants are "abdominal breathers." They rely almost entirely on their diaphragms rather than their chest walls for lung expansion. When the infant's diaphragm falls during each inspiration, the abdomen protrudes, giving the appearance of a "retracting" chest and, hence, the appearance of labored breathing. The key here is to examine the intercostal spaces — the spaces between the ribs. If there is no skin retraction with each breath in this space, the infant's respiratory efforts are probably normal for her age.

Assessment. Children of this age are relatively easy to assess. After observing general appearance, the EMT may approach without much concern that his presence will upset the infant (Figure 1-1). The examination should proceed, however, from "toe-to-head," since examination of the head may cause the infant to cry. The examination need not take place in the parent's arms, because small infants have not yet developed "separation anxiety."

Figure 1-1 EMT examining an infant.

Finally, the tension (not the shape or size) of the fontanel of an infant between 0 and 6 months old should be checked routinely. (The fontanel is also known as the "soft spot." It is an opening in the infant's skull in the midline just above the forehead. It is occasionally present up to the age of 18 months of age.) The fontanel is best examined when the infant is quiet and in the upright position, assuming that there is no contraindication to placing the infant upright, such as shock or the suspicion of cervical spine trauma. The fontanel of an infant who is crying and lying down will often feel firm. When calmed and placed in the upright position, however, the infant's fontanel will usually be soft, ruling out increased intracranial pressure.

6 MONTHS TO 3 YEARS

Characteristics. This is the most difficult age to evaluate. These children typically present a major challenge to medical personnel. The younger infants will demonstrate "stranger anxiety." The older infants and toddlers will display "separation anxiety" and "negativism," with virtually no capacity for rational understanding of events, despite an appearance of alertness and understanding. Approaching these children properly is critical not only from a psychological standpoint but also from a medical standpoint. The toddler who is approached too aggressively may be psychologically traumatized and may

also deteriorate medically. For example, the child with a partially obstructed airway may develop increased airway obstruction when agitated (see Chapter 3).

Assessment. There are several keys to successful evaluation of these children (Figure 1-2). The first and most important key is to ask a calm and cooperative parent or other family member to assist during the examination. If the parent is calm, the child may be examined in the parent's lap or arms. Ask the mother to reassure the child and to provide simple explanations to the child in the child's vocabulary. Let the parent hold the oxygen mask or temporarily support the child's head and neck. Allow the parent to hold the stethoscope on the child's chest or slowly move an extremity to check for tenderness. Use the parent to perform as many of these procedures as possible.

A second key to successful examination of these children is to stay low! Children are threatened by strangers who stand over them. They are better dealt with at their eye level. Therefore, it is best to kneel down and address the child at their eye level or lower.

Third, talk to the child calmly and give her at least a few moments to get accustomed to you and to the situation before the physical examination. The child in this age group should also be examined from toe-to-head. (Of course, for the obviously critically ill child, examining the ABCs takes priority.) If the child becomes agitated by a certain activity (for example, placing a cold stethoscope on the child's chest), stop and either change the approach (place the stethoscope on the shirt) or defer the procedure until later in the examination in order to maximize the information gained from the entire assessment. Finally, if all attempts to examine the child are resisted, be reassured that this is probably an indication that the child is really not very ill or badly injured!

Figure 1-2 EMT examining a toddler. Notice that (1) the child is in the mother's lap, (2)the EMT is at the child's eye level, (3) eye contact is made to distract the child, and (4) the stethoscope is placed on the child's shirt rather than directly on her chest. In some situations, no family member will be sufficiently calm and cooperative to be of assistance. Children mirror the behavior they see around them. Hysterical behavior from adults begets hysterical behavior from children!

3 TO 10 YEARS

Characteristics. The younger children in this age bracket may regress to the mental state of a toddler during a stressful situation. Therefore, the approach to many 4-year-old children will be similar to that used for 2-year-old children. The older children in this category are rapidly developing a capacity for rational thought and the desire to be "grown up." Still, while others see the situation in terms of life or death, the child is often most preoccupied with concerns of pain, separation and guilt. More than a few medical professionals have been brought close to tears by a 4-year-old child who reacts to a procedure by saying, "Please don't. I promise I'll be good from now on.

Assessment. The older child should be approached with a calm, truthful and simple explanation. She should be reassured that either a procedure will not be painful or that she will be informed of precisely when and how much pain to expect. Informing her that the parent can stay with her during the ride to the hospital will go a long way toward winning cooperation. Furthermore, if you know the receiving hospital permits parents to stay with their children as much as possible, telling the child this will be reassuring. The older child can often provide useful answers to simple questions such as "Where do you hurt?" A toe-to-head approach is still appropriate for most of the children in this age group.

ADOLESCENTS

Characteristics. Adolescents display great variability in their reactions to trauma and illness. They may be calm, mature and helpful, or they may be hysterical. They may be modest or provocative. They may provide information or intentionally withhold or even falsify it.

Assessment. Approaching these patients as one would approach an adult should be tried first. The EMT should be firm and avoid becoming angry if an intentional lack of cooperation is suspected. He should watch for evidence of alcohol or drug abuse. It is helpful to reassure the adolescent, if appropriate, regarding possible cosmetic or functional losses that might result from injuries—issues of high priority to most adolescents. The EMT might say, for example, "Injuries like these often look much worse than they really are.

Some adolescents may be hesitant to supply complete details of an injury or illness in the presence of a parent. If some discomfort during the conversation or incompleteness of facts is noted, a possible course of action would be to interview the patient alone if the situation permits.

ASSESSING THE PEDIATRIC

PATIENT'S ABCs (PRIMARY SURVEY)

The abbreviation ABCD (airway, breathing, circulation and disability) summarizes and organizes the priorities during the assessment of a pediatric patient just as well as it does for the adult patient. The

individual parameters used, however, differ. For example, though vital signs tend to be one of the mainstays of the primary survey of the adult patient, they are less useful when evaluating a pediatric patient because they vary so greatly with age, anxiety and temperature. They are also more difficult to accurately measure in the pediatric patient. The most useful parameters for assessing the status of the pediatric patient's ABCs are reviewed below and in Table 1-2.

Table 1 – 2   PEDIATRIC PRIMARY SURVEY

Airway	Breath sounds
Breathing	Chest movements, color, respiratory rate
Circulation	Peripheral pulse strength, capillary refill, temperature/color of extremities, heart rate, blood pressure
Disability	General appearance, pupils, fontanel, pediatric Glasgow Coma Scale, muscle tone

AIRWAY

Assessment of the patency of the pediatric patient's airway is very similar to that of the adult. Breath sounds provide the key (Table 1-3). The difference between assessment of the breath sounds in the pediatric and adult patient is the care that must be exercised in auscultating the infant or child's chest. Approaching the alert infant or child too quickly and placing a cold stethoscope on the child's chest can produce agitation and crying. At a minimum, this will interfere with auscultation. More important, the agitation may compromise the child's airway and increase respiratory distress. For the awake, alert child, auscultation can be deferred until later in the examination. If either stridor or wheezing is audible without a stethoscope, little, if any, additional information of value will be gained by auscultation with a stethoscope. Finally, auscultation through the child's shirt or with the plastic bell (warm) rather than the metal diaphragm (cold) will usually be quite adequate. Airway compromise, when noted, should be managed with manual airway maneuvers and adjunctive devices as necessary. For more information on management of airway compromise, refer to the chapter on cardiopulmonary resuscitation (Chapter 6).

BREATHING

Work of breathing is the best single parameter to use when assessing adequacy of a child's ventilatory status. Labored breathing is indicated by intercostal, suprasternal or supraclavicular retractions (Figure 1-3). On inspiration, flaring of the nares may also be present. A point to remember is that a child who is crying loudly is rarely in any substantial respiratory distress.

Table 1 – 3   INTERPRETATION OF BREATH SOUNDS

Sound	Cause
Stridor	Upper airway obstruction
Wheezing	Lower airway obstruction
Rales/rhonchi	Fluid without associated major airway obstruction
Absent	Complete obstruction

Pulse oximetry, if available, is very useful when assessing a child's respiratory status if the child will cooperate with its application. A tape probe applied to a toe is usually better tolerated than a clip-on. A reading over 90 without oxygen or over 95 with oxygen is reassuring that at least a short transport can proceed without further respiratory intervention.

Respiratory rate, a difficult measurement to obtain on infants and children, varies greatly with age, body temperature and anxiety. Hence, respiratory rate is of limited value when assessing the severity of a child's respiratory distress. Bradypnea, when it accompanies altered mental status and/or shock, however, may be critical and should be supported with high flow oxygen. Ventilatory assistance should also be considered, particularly if these patients are cyanotic or experience increased work of breathing. Color is obviously helpful when there is frank cyanosis. However, the absence of cyanosis may be deceiving because the relative anemia of children compared to adults prevents cyanosis from developing until the oxygen content of the child's blood is very low. Breathing that is absent or determined to be inadequate must be assisted with positive pressure ventilation. (See Chapter 6, Cardiopulmonary Resuscitation.)

Table 1 – 4   RESPIRATORY RATES FOR AGE

Age	Respiratory rate
Newborn	40
Infant (<1)	30
Toddler (1-3)	25
Child (3-8)	22
Older child (8-12)	20

CIRCULATION

Peripheral circulatory signs, such as the strength of the radial pulse, temperature, color of the extremities and speed of capillary refill, provide the most useful means of assessing a pediatric patient's circulation. Normally, the radial pulse is easily palpated, the extremities are warm, the nail beds are pink, and capillary refill time is less than two seconds. Heart rate and blood pressure, the cornerstones of circulatory assessment of the adult, are somewhat less useful in pediatric assessment. Heart rate, like respiratory rate, varies with age, body temperature and anxiety (Table 1-4). Blood pressure is a difficult measurement in children. The proper cuff size is often not available, making blood pressure measurement extremely inaccurate. For infants less than 1 year of age, an ultrasonic method must be used to obtain an accurate blood pressure reading. Also, if the child is alert, she often resists having her blood pressure taken. Furthermore, blood pressure is a poor indicator of early shock in children because children have a great ability to constrict their blood vessels when in shock. This enables them to maintain a relatively normal blood pressure until volume depletion has progressed to a severe degree. The management of shock is discussed later in the text.

DISABILITY (CNS)

The principle behind the Glasgow Coma Scale (GCS), namely, rating a patient's best response to verbal and painful stimuli as a means of assessing mental status, is valid for pediatric patients. However, the GCS is difficult to directly apply to children because of children's inability or reluctance to give the full

range of verbal responses used by the GCS. For this reason, a modification of the GCS for pediatric patients has recently been developed (Table 1-5). The EMT is encouraged to be familiar with the modified scale's descriptive approach to grading infant responsiveness. However, as discussed in Chapter 5, the actual determination of a score is not always practical in the pre-hospital setting.

Table 1 – 5   BLOOD PRESSURE AND HEART RATE NORMS FOR AGE

Blood pressure	Heart rate	(minimal systolic)
Newborn	100 – 160	*
Infant (<1)	100 – 160	*
Toddler (1-3)	100 – 160	80
Child (3-8)	70 – 170	80
Older child (8-12)	55 – 110	90
* Not listed because field blood pressure measurements in these age groups are unreliable.		

In addition to the GCS, central nervous system status is assessed by evaluation of pupils, muscle tone and the fontanel. Muscle tone is particularly important because it can provide the only clue to subtle seizure activity, which is a common problem in the pediatric age group. Assessment of muscle tone is accomplished by gentle direct manipulation of the extremities—checking for resistance and spontaneous movement. The fontanel provides a window for direct measurement of intracranial pressure in infants. It is best assessed when the infant is quiet and upright. A tense fontanel (not necessarily bulging) is highly suggestive of increased intracranial pressure.

The following two radio communications illustrate many of the principles of pediatric assessment discussed above. The first communication is of limited value.

> *We are on the scene of a 1-year-old boy with a 24-hour history of respiratory distress. He is agitated. Auscultation is difficult because of crying. The respiratory rate is 30, pulse 140, blood pressure could not be obtained. There is no cyanosis.*

This child's agitation could be from hypoxia or stranger anxiety. The respiratory rate and lack of cyanosis do not help to differentiate between these two possibilities. The child's circulatory status cannot be assessed from the heart rate.

However, that the child can effectively resist the EMT's attempt to obtain a blood pressure probably indicates that circulation is adequate.

The second communication concerning the same patient is much more revealing:

> *We are on the scene of a 1-year-old boy with a 24-hour history of respiratory distress. On arrival he was alert, calm in mother's arms and demonstrating moderate work of breathing. There was faintly audible wheezing without a stethoscope and no cyanosis. Extremity exam demonstrated strong pulses and goad capillary refill. His fontanel is soft. He becomes agitated and offers much resistance when examined closely.*

This communication conveys an accurate picture of the severity of the patient's condition, in this case mild to moderate, although moderate work of breathing identifies potential for later deterioration and the need for transport.

Table 1 – 6   PEDIATRIC GLASCOW COMA SCALE

Eyes Opening		
Score	>1 year	< 1 year
4	Spontaneously	Spontaneously
3	To verbal command	To shout
2	To pain	To pain
1	No response	No response
Best Motor Response		
Score	> 1 year	< 1 year
6	Obeys	Spontaneous
5	Localizes pain	Localizes pain
4	Flexion-withdrawal	Flexion-withdrawal
3	Flexion-abnormal (decorticate rigidity)	Flexion-abnormal (decerebrate rigidity)
2	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)
1	No response	No response

Best Verbal Response			
Score	>5 years	2-5 years	0-23 months
5	Oriented and converses	Appropriate words and phrases	Smiles, coos appropriately
4	Disorientated and converses	Inappropriate words	Cries, consolable
3	Inappropriate words	Persistent cries and/or screams	Persistent inappropriate crying and/or screaming
2	Incomprehensible sounds	Grunts	Grunts agitated/restless
1	No response	No response	No response
TOTAL 3 - 15			

ENVIRONMENTAL ASSESSMENT

We are all dependent on the quality of our environment, including other family members and our economic and social resources. However, the infant or child is obviously more dependent on her immediate environment than is the adult. Therefore, the EMT should routinely assess a child's environment as part of his assessment of the child. Indeed, because the EMT is usually the only health professional to be able to assess a child's home environment, his input is critical to the complete assessment of the child. This assessment must be made tactfully. It is obviously not appropriate to ask personal questions not clearly related to the child's medical complaint or to otherwise openly invade the privacy of the family. Nevertheless, many pertinent observations may be made regarding factors such as the following:

1. Interaction among family members.
2. Orderliness and cleanliness of the home.
3. Safety of the home for small children (for example, gates on stairs).

4. Characteristics of the scene of an accident that are consistent or inconsistent with the description of the accident and the child's apparent injuries.
5. General appearance of other children in the family.

Such observations should be objectively described in the chart and described in detail to the emergency department physician accepting medical responsibility for the child. These observations may have great bearing on decisions such as whether or not to report a child as a victim of suspected child abuse. However, they may also help the physician to determine that an overwhelmed mother needs practical kinds of assistance or to determine that a family needs intensive education in accident prevention techniques.

SUMMARY OF KEY POINTS

1. The accurate assessment of a child's general appearance is a reliable means of assessing the severity of her illness or injury.
2. Infants and children of different ages react differently to an examination by a health professional. Consequently, the EMT must vary his approach and expectations according to the age of the patient.
3. Toddlers are the most difficult age to examine. When they resist, the assessment of general appearance may be the major source, and at times the only source, of information of use to the EMT. Furthermore, when children suffer from conditions that are aggravated when they become agitated or upset, the only part of the examination that may be safely accomplished may be the assessment of the general appearance.
4. The ABCs in infants and toddlers are best assessed using respiratory sounds and efforts, the strength of peripheral pulses and capillary refill, and, again, general appearance. Vital signs are of limited value when assessing infants and toddlers under field conditions.
5. Assessing the child's environment is as much a part of her examination as assessing her ABCs.

Chapter 2

Family Assessment and Management

OBJECTIVES
1. From a list of possible alternatives, identify the potential ways both children and their parents may respond to an emergency and differentiate between productive and nonproductive EMT responses to that child or parent.

Few events stress a family more than an acutely ill or injured child. The responses of family members run the gamut from denial to hysteria, from rational to irrational, from compassion to anger.

To be maximally effective, all health care providers must deal objectively with the emotions they encounter. To accomplish this, it is helpful to view the emotional response of a child or a family member to acute illness or injury as yet another "symptom" within the symptom complex presented by the child. For example, an EMT may react in two ways to a parent who angrily says, "Don't waste time examining her, just get her to a hospital quickly." Optimally, the EMT will take an objective point of view, interpret the anger as stemming from anxiety or guilt, and calm and reassure the parent in a professional manner. Alternatively, the EMT might react personally or subjectively, resulting in a defensive and less than compassionate response. Clearly, the first approach would be much more effective "therapy" for the parent's anger.

The remainder of this chapter will review some of the more common responses of parents to an acutely ill or injured child. By understanding these responses it becomes easier to view them objectively and to react to them in ways that generate cooperation between family members and health professionals.

ANXIETY

The most common reaction of a family member to a child's illness or injury is anxiety fostered by fear. Fear of loss of life or limb and fear of disfigurement are most common. Although EMTs and other emergency medical personnel must be realistic in the reassurance they provide, it will often be possible to reduce these fears with such statements as "such injuries usually look worse than they really are." Direct acknowledgment of a parent s anxiety can also be a very effective way of reassuring a parent and reducing this anxiety. For example, a statement such as the following can be useful, "I can see that you're very concerned and upset. Let me assure you that it's common for a child to be sleepy after a seizure. The important thing is that Susie is breathing just fine. Her blood pressure is normal. She'll probably be waking up by the time we get to the hospital."

Gentle touching can also be a powerful means of demonstrating understanding and, thereby, reducing anxiety. For example, while expressing understanding, as illustrated above, a gentle hand on a parent's shoulder will often provide more comfort and bring about more self-control than the most eloquent words of reassurance.

Fear of pain and discomfort is another major concern for many parents and children. In fact, for many children this is the overriding concern. From past experience with illness, many children have come to

expect that medical care equals shots or other painful procedures. Therefore, as soon as the EMT deter-mines that he will not need to perform any painful procedures, he should tell the child. On the other hand, the EMT must not make false promises. A child remembers lies and will likely not trust any medical personnel if she has been lied to.

If the EMT must perform a procedure that temporarily increases pain, it is useful to forewarn family members and reassure them that it is necessary. Once a decision is made to perform a procedure, such as the application of a traction splint, and the family and the child have been prepared, it is generally best to move quickly. Stopping at various points to further reassure the child and family will probably not be effective and will only prolong the period of heightened anxiety and pain. When faced with this situation, the EMT must remember to explain to the family his reason for proceeding with due speed or he will be perceived as insensitive. Also, it is important to prepare equipment and assistance in a manner that will permit the to be performed quickly. Finally, potent analgesics, such as morphine (0.1 mg/kg JM or IV) are effective and safe when administered to children in proper dosages. When concerns regarding circulatory compromise or head injury do not preclude their use, these drugs should be employed by EMTs under appropriate medical control in the same manner that these drugs are used for adult patients.

Fear of loss of control will be a paramount concern to some family members. These family members may demonstrate their anxiety by attempting to exert control over health professionals either actively or more passively by resisting recommendations or directions given. The best tactic to manage such situations is to offer the family a measure of control. Options an EMT may offer the family to grant them a measure of control over the situation include the following: "Which hospital would you prefer?" and "Would you like to carry your child to the ambulance?"

HYSTERIA

When a family's anxiety overwhelms its ability to cope, hysteria may result. The health professional must deal with hysterical reactions with firmness. Statements such as "Mother, we need your help. Your child will do better if you can be calm and help us to calm your child," may help hysterical individuals gain control of themselves. Directing such a parent to perform specific simple tasks may also be useful. For example, the EMT might say, "Please get her medicines and bring them along."

If all else fails, separating the hysterical family member from the child may be necessary. In fact, it may be the key to calming some children! This is a particularly effective course of action if there are other family members who can remain with the child to provide comfort and reassurance or if the infant or child is so young or so unresponsive to her environment that this separation will not be threatening. However, because of toddlers' natural separation and stranger anxieties, this technique should be a last resort.

In summary, fears of loss of life or limb, pain, or loss of control may cause family members to inject tremendous anxiety into a medical emergency situation. The infant or child, sensing the anxiety about her, will feel more anxious and become more infantile and less cooperative. It is critical, therefore, that emergency health professionals learn techniques for lowering the anxiety level of a family. This is

particularly difficult in the pre-hospital setting where the brief nature of the encounter makes it difficult to relate to individuals in ways that reassure them or otherwise bring them under control.

ANGER

Anger is often a response to anxiety. However, anger may indicate the presence of other concerns. Guilt is one of these concerns. A parent who feels guilty about her child's predicament may attempt to overcompensate for her sense of inadequacy by being overly demanding of health care professionals. It is particularly difficult to remain objective when confronted with an angry parent. Yet, to react subjectively and become angry with the parent will only heighten the parent's sense of inadequacy and produce a more angry response. Even if the parent's accusations are totally wrong, it is best to respond in a way which acknowledges her concern for her child. For example, a parent may say, "You took too long to get here." A calming response from the EMT might be, "I understand how difficult it is for a mother who is concerned about her daughter to wait even a few more minutes than you might have expected." Another technique is the "yes, but" technique: "Yes, you're right, the traffic was terrible. But now that we are here, we need your cooperation to help us understand what is wrong with your child." Any angry response to a medical emergency may also reflect significant interpersonal problems within the family. The key response of the EMT is to avoid involvement with the conflict. For example, the EMT might redirect the attention of two quarreling parents or a parent who is berating a child for causing an accidental injury with an unrelated question. For example, "How has her past health been?" or "Does she have any allergies?" Such questions tend to direct attention away from more sensitive issues that are generating conflict.

HIDDEN AGENDAS

In pediatric emergency medical situations a hidden agenda is any matter, other than the well-being of the child, that is pursued as an objective along with the objective of medical care for the child. The presence of hidden agendas greatly complicates the management of a family's emotional reaction to a child's illness or injury. The following examples illustrate just a few possible hidden agendas that may surface or be suspected during the interaction with family members.

Concealing Abuse: The family of an abused child may wish to conceal that abuse caused the child's injuries.

Unorthodox Medical Beliefs: A family with unorthodox medical beliefs may be resistant to a particular form of therapy or transport to a certain medical facility.

Parent Rivalry: One parent may be attempting to dramatize the severity of a child's illness in order to manipulate the other parent or implicate that parent as a poor caretaker.

Hidden agendas are hidden to various degrees. In the case of the abused child, the family will try very hard to conceal their other objective. In the case of unorthodox medical beliefs, the family may be very frank about their concerns. Hidden agendas should be suspected whenever a family's response to a medical emergency just doesn't "add up." When a hidden agenda is suspected, very gentle probing to draw out these other concerns may be tried but will often not succeed. The EMT may say, "You are clearly very concerned about Susie. Do you have any other special concerns in addition to getting her

medical help as quickly as possible?" In most cases, however, the EMT who suspects a hidden agenda will have to rely on observing for subtle clues to the nature of the family's concern.

Treating the child of such a family can be difficult and frustrating. The first key is to remain professional and objective. It is helpful to realize that when the concept is broadly defined, everyone has a hidden agenda—even a health professional whose training has emphasized objectivity. Secondly, it is useful to remember that the family probably does want emergency health care to return the child to good health. By repeatedly directing attention to this goal, the effects of the other objective can be blunted. If the hidden agenda openly surfaces, then offering respect for this objective will usually be helpful. It is simply respect for their beliefs, rather than actions directly in accordance with their beliefs, that is of greatest importance to a family. Another tactic that is occasionally helpful when a hidden agenda surfaces in one family member is to appeal to another family member for support for a given course of action.

Possible responses to the situations presented in the examples above may illustrate the principles just described.

Concealing Abuse: When the EMT suspects attempts at concealing pertinent facts regarding a child's injuries, relating all questions to the immediate care of the child is a good ploy: "The physicians at hospital X have instructed us to go over exactly how the accident occurred so that they will know what specific injuries to look for."

Unorthodox Medical Beliefs: One approach might be to offer respect for the medical beliefs: "I respect your feelings regarding the use of blood products. It is my understanding that the physicians at hospital X also make every effort to respect the wishes of parents in this regard."

Parent Rivalry: One possibility is to take a separate history in private from some other family member in an attempt to ascertain a more objective history.

In summary, the stress of an acutely ill or injured child may stimulate a variety of reactions from family members, many of which will be very constructive. Families may be pulled together by the stress and discover strengths they did not know existed within themselves. Other families, however, will react with anxiety, hysteria, anger, or other feelings that compound the problem at hand. When dealing with an adult patient, the option of separating the difficult family members from the victim is particularly attractive. With children this option may be, at times, the only means of dealing with the situation as well, but it may not be the most attractive alternative. Therefore, it is particularly critical when dealing with pediatric patients that the EMT develop techniques for bringing family members under control, relieving anxiety, and diffusing anger (see Table 2-1). It is critical not only for the immediate management of the child but also for the child's subsequent perceptions of the events surrounding the illness or injury. If she perceives her family losing control, she will feel less in control and be at greater risk to develop emotional scars from the experience. It is common for a child who has experienced an acute illness or injury to be troubled by nightmares, phobias, or other reactions for a long time after her medical condition has totally resolved. A child whose initial perceptions are those of a family coming together and providing support and comfort is less likely to suffer from emotional scars after her physical wounds have healed.

Table 2 – 1   FAMILY REACTIONS/EMT RESPONSES

REACTION	RESPONSE
Anxiety/hysteria	Reassurance
	Understanding
	Touching
	Pain control
	Redirection
	Firmness
	Separation
Anger/resistance	"Yes, but"
	Redirection
	Gestures of shared control
	Separation
	Reassurance
Hidden agendas	Acknowledgment
	Respect
	Redirection
	Appeal to other family members

SUMMARY OF KEY POINTS

1. The intense emotional responses generated within a family by the sudden illness or injury of a child must be dealt with objectively.
2. Fear of loss of life or limb and fear of loss of control contribute to a family's anxiety response.
3. Guilt and hidden agendas contribute to a family's anger.
4. The fear of pain dominates the response of most children, as well as many parents.
5. Health professionals must develop techniques for managing a family's emotions in much the same way that they learn techniques for achieving venous access, for example.
6. Failure to calm the emotions of the family may interfere with the EMT's ability to provide optimal care and contribute to the subsequent psychological burden of the episode, which remains with the child.

Chapter 3

Pediatric Respiratory Emergencies

OBJECTIVES

1. From a list of assessments, select those which best identify the severity of a respiratory disorder.
2. Given a list of signs and symptoms, separate those that are consistent with each of the causes of respiratory distress discussed in this course.
3. Determine appropriate management of respiratory distress for each of the various causes.
4. Given a patient scenario exhibiting respiratory distress, determine its cause and appropriate management.

The respiratory system plays a major role in the epidemiology of pediatric medical emergencies. For example, 65 percent of all cardiopulmonary arrests in the pediatric age group are precipitated by a respiratory problem. Four of the eight most common nontraumatic pediatric conditions resulting in admission to a hospital involve the pulmonary system: asthma, pneumonia, croup/epiglottitis, and near-miss sudden infant death syndrome. It is often said that the respiratory system is to pediatric emergency medicine what the cardiovascular system is to adult emergency medicine.

Traditional discussions of respiratory distress begin with a differential diagnosis, proceed to assessment tactics used to narrow down the differential diagnosis, and then address therapy. Unfortunately, emergency medical personnel do not have the luxury of proceeding in such a textbook fashion when confronted with a patient in distress.

Often treatment must begin before diagnosis has been given much thought. In children, the manipulation involved in the initial assessment is a form of treatment (or mistreatment) that takes place before a judgement regarding diagnosis has been made.

For these reasons, this discussion will not begin with diagnostic possibilities. Rather, it will proceed according to the thought processes that should occur when an EMT, nurse, or physician is confronted with a pediatric patient in respiratory distress of nontraumatic origin in the pre-hospital setting. The order of this thought process is as follows:

1. How severe is the patient's respiratory distress?
2. During initial evaluation, in what position should the infant or child be placed?
3. Should oxygen be offered before a complete assessment has been made? Should the oxygen be delivered with positive-pressure ventilation? (Positive-pressure ventilation in this text refers to bag-valve-mask or bag-tube ventilation. Oxygen-powered ventilators are never used on pediatric patients.)
4. Is there airway obstruction? If so, does it require field management?
5. How should the patient be managed during transport?

SEVERITY?

There are many parameters by which to judge the degree of respiratory distress. These include retracting, behavior, nasal flaring, color, respiratory rate and breath sounds. As discussed in Chapter 1, retracting tends to be one of the most useful assessment parameters. Retracting represents increased effort in breathing. The diaphragm must pull down with increased force to enable air to flow past an obstruction. The resulting suction within the chest causes the relatively thin, soft tissues of the chest wall of the infant or child to retract in and around the rib cage. The sign is particularly common in pediatric patients in respiratory distress for two reasons. First, pediatric respiratory distress is usually secondary to an obstruction. Second, the child's respiratory system is generally able to perform the increased work of breathing required to move air around this obstruction because of her healthy state prior to the onset of illness.

Retracting is most useful when assessing infants and small children; it is less useful when assessing obese children and muscular adolescents. Because the soft tissues overlying the rib cages of such patients are thick, retracting does not predictably accompany increased work of breathing.

Behavior change is another useful indicator of the degree of respiratory distress. Fatigue may indicate that a child is tiring from prolonged respiratory distress. Irritability may be a sign of hypoxia. Indeed, the agitation of a hypoxic child with, for example, asthma is not unlike the struggling of a drowning victim! Both are reacting to the sensation of suffocation.

Skin color is a definite indicator of respiratory distress when the color is blue. However, a pediatric patient may have a dangerously low blood-oxygen content even without the presence of frank cyanosis. The explanation for this phenomenon lies in the relative anemia of the infant and child. Because children have less hemoglobin than adults and cyanosis only occurs when a critical level of hemoglobin is without oxygen, the oxygen content of the blood must fall to very low levels before frank cyanosis is evident.

Respiratory rate must be cautiously interpreted as an indicator of severity of respiratory distress in the pediatric patient unless it is very slow (that is, the child is gasping). It is difficult to obtain an accurate respiratory rate in a pediatric patient. Also, the great variability of respiratory rate with age, fever and anxiety make interpretation difficult. Finally, and most importantly, because most respiratory distress in pediatrics is secondary to obstruction, the respiratory rate is not necessarily elevated when distress is severe. The obstruction simply does not permit the infant or child to move air fast enough to have a high respiratory rate. A normal respiratory rate in a child (Table 3-1) with other evidence of respiratory distress is far more worrisome than a rapid rate.

Finally, breath sounds are of limited use, particularly in the noisy pre-hospital setting, in assessing severity of respiratory distress. For example, loud wheezes may involve minimal obstruction. A severely asthmatic patient, on the other hand, may have no wheezing whatsoever because so little air is being moved through a narrowed bronchial tree.

Table 3 – 1   RESPIRATORY RATE – NORMAL VALUES FOR AGE

AGE	RESPIRATORY RATE
NEWBORN	40
INFANT (<1)	30
TODDLER (1-3)	25
CHILD (3-8)	22
OLDER CHILD (8-12)	20

In summary, the severity of respiratory distress in the pediatric patient can and should be assessed from a distance as part of assessment of general appearance using retractions and behavior, not respiratory rate and breath sounds. Assessing severity in this manner will keep the child calm - a key to the successful management of the pediatric patient in respiratory distress.

POSITIONING?

After quickly assessing severity from across the room, the next step is to approach the child for more detailed observations and initiation of therapy. During this phase the EMT may intentionally or inadvertently alter the child's position and, in the process, dramatically affect the child's respiratory status. The positioning of a patient during closer assessment and therapy should be regarded as a major therapeutic intervention of no less importance than, for example, oxygen therapy or the administration of medications.

The optimal position for the small infant or any unconscious pediatric patient is the supine air sniffing position (Figure 3-1). All other patients should be allowed to choose their position of comfort (for example, in the parent's arms or lap, leaning forward, or supine). Forcing a patient into a different position may worsen respiratory distress and even precipitate respiratory arrest. For example, the patient with epiglottitis will breathe much more effectively and with less airway obstruction when leaning forward. Forcing this patient to lie down could precipitate complete airway obstruction. Many severe asthmatic children will also prefer to lean forward and "tripod"— using their arms to support their upper torso, thereby improving the mechanical efficiency of their accessory muscles of respiration.

Another reason for the importance of thoughtful positioning of a pediatric patient in respiratory distress is that ill-advised repositioning of a child can cause her to become agitated, worsening her airway obstruction. For example, the child with   a narrowed upper airway caused by croup is essentially breathing through a straw. Just as a straw collapses when a sharp breath is drawn through it, the pliable tissues of the small child's upper airway also collapse when the child inhales harder because of agitation (Figure 3-2). Abruptly

Figure 1-3 Air sniffing-jaw thrust position. Notice that the neck is slightly flexed and the head is rotated back on the neck so that the face looks directly upward.

25

placing a child in respiratory distress on a stretcher or even having her lean forward when she is reasonably comfortable can cause the child to deteriorate. Hence, it is important to make a conscious decision regarding proper positioning early in a child's evaluation.
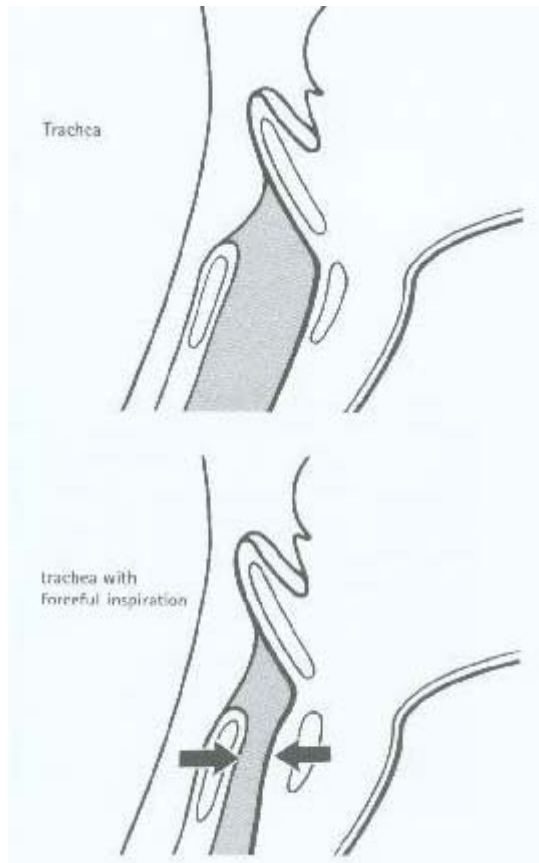
OXYGEN AND POSITIVE PRESSURE VENTILATION?

Administering 100 percent oxygen for a limited period of time will never be detrimental to the pediatric patient (in contrast to the adult patient with chronic pulmonary disease, for example). However, the means by which the oxygen is administered may so agitate the child that respiratory distress is worsened rather than improved. Therefore, a good rule of thumb is to offer oxygen to any pediatric patient in respiratory distress but to withdraw it if it produces marked agitation. There are various techniques for the administration of oxygen to infants and children. For newborns and small infants it is desirable to avoid a high flow rate because of its cooling effects. For these infants, pediatric nasal cannulas work well when a moderate concentration of oxygen will suffice. Nasal cannulas take advantage of the fact that small infants are primarily nasal breathers. Hence, relatively low flows of 2-3 liters per minute directed into the nose provide these infants with a substantial increase in inspired oxygen. When greater than 50 percent oxygen delivery is desired, a mask with an easily collapsible, unvalved reservoir is best. These masks are labeled "partial rebreather masks." Non-rebreather masks have valves or semirigid reservoirs that offer too much resistance to be effective with the weak inspiratory forces of the small infant.

Figure 3-2 Effect of increased inspiratory force on airway size.

For toddlers and older children a non-rebreather mask will deliver the highest concentration of inspired oxygen obtainable without resorting to the use of positive pressure. The mask may be better tolerated by the toddler if it is held to her face by the mother rather than strapped around her head (Figure 3-3). Referring to the mask as a "space mask" may also win over a few reluctant toddlers. If these measures fail, placing oxygen tubing through the bottom of a paper cup and instructing the parent to hold the cup close to the child's face may be accepted by the child (Figure 3-4). If the toddler successfully resists all attempts at oxygen administration, it can be taken as evidence that her hypoxia is not so severe that forceful administration of oxygen is warranted.

As part of the decision to administer oxygen, the EMT must determine if passive oxygen administration (such as with mask or cannula) is adequate or if positive-pressure ventilation is required. This decision must be made quickly! If, in fact, positive-pressure ventilation is needed, even a brief delay could make a crucial difference in the child's final outcome. A simple rule of thumb generally can be applied to the situation of a child in respiratory distress: positive-pressure ventilation is needed if there is apnea,

gasping, or persistent cyanosis despite a brief (less than 30 seconds) trial of high-concentration oxygen administration. Positive-pressure should be initiated with a bag and mask. If it is successful in improving the child's condition as judged by color, responsiveness, pulse, etc., positive-pressure ventilation should be continued for the duration of the transport with either mask or endotracheal tube. If endotracheal intubation can be achieved quickly, it is preferable to positive-pressure ventilation by mask because of the risk of vomiting and aspiration with the latter technique.

OBSTRUCTION?

Having assessed severity, decided on the appropriate positioning of the child, and offered oxygen or begun positive-pressure ventilation (all within a few seconds), the next concern is the presence of partial or complete airway obstruction. If the child requires positive-pressure ventilation, the best indication of airway patency is chest rise. If the chest rises with positive-pressure ventilation, then an adequate airway can be assumed. If it does not rise, even after the airway is repositioned and increased pressure is used, then obstruction must be assumed. In this situation the maneuvers below should be attempted in the order listed until positive-pressure ventilation is successful:

1. Airway clearing maneuvers (see Chapter 6) if foreign body is suspected.
2. Repositioning the head, neck, and mandible, including elevation of the head with a folded towel and increased extension of the head (the exaggerated air-sniffing position).
3. Trial of an oral or nasopharyngeal airway.
4. Use of increased pressure during positive-pressure ventilation.
5. Intubation.
6. Needle cricothyroidotomy (if local protocol permits).

Figure 3-3 Mother preparing to administer oxygen via a mask.

Figure 3-4 Mother preparing to administer oxygen via tubing placed through the bottom of a paper cup.

Even if all steps in the sequence are attempted, the EMT should be so proficient at this sequence that the first attempt at intubation is delayed by no more than 30 seconds while other efforts at establishing an airway are tried. If the patient is breathing spontaneously, breath sounds provide the best clue to the presence and nature of airway obstruction and the likely location of that obstruction. Stridor implies upper airway obstruction. Wheezing implies lower airway obstruction. Rales and rhonchi do not indicate significant airway obstruction, with the exception of rhonchi, audible to the naked ear suggesting fluid or the tongue obstructing the upper airway. Table 3-2 lists the possible causes of stridor, wheezing, and rales/rhonchi.

Table 3 – 2   CAUSES OF STRIDOR, WHEEZING, AND RALES OR RHONCHI

Breath Sound	Possible Causes

Stridor	Upper Airway Obstruction
	    Croup
	    Epiglottitis
	    Foreign body
	    Tongue

Wheezing	Lower Airway Obstruction
	    Asthma
	    Bronchiolitis
	    Foreign body

Rales or rhonchi	Mucus or fluid in upper or lower airway
	    Pneumonia
	    Bronchitis
	    Aspiration

Stridor, a crowing sound on inspiration, is most commonly caused by croup (Figure *3-5)*. Croup is a viral infection of the trachea, typically affecting older infants and toddlers less than 3 years old. However, croup does occur in older children. The infant with croup usually has a low-grade fever, does not appear "sick" unless respiratory distress is very severe, and has a barky cough similar to the bark of a seal.
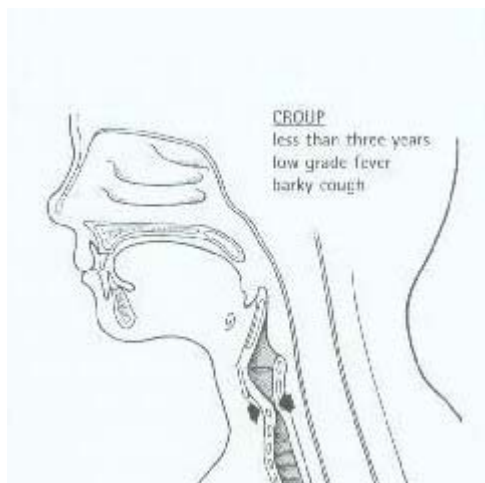

Figure 3-5 Croup is a viral infection of the trachea.

Epiglottitis is an uncommon but much feared cause of stridor in children because of its potential for rapid progression and sudden deterioration. Epiglottitis is a bacterial infection of the epiglottis (Figure 3-6). The child with epiglottitis is usually older than 2 years, has a high fever, and appears "sick" (probably from bacteria invading the blood stream) even if respiratory distress is not great. The child with epiglottitis will usually choose to lean forward and will often drool because of the pain with swallowing. Because of the Hib vaccine, epiglottitis is now a rare illness.
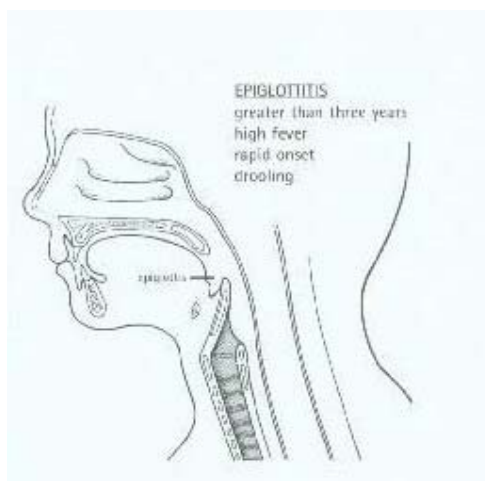
Foreign body aspiration is generally easy to differentiate from croup and epiglottitis. The child who has aspirated a foreign body will have had a sudden onset of stridor and no fever or preceding illness.

Wheezing, a musical sound loudest on expiration, is most commonly the result of asthma or bronchiolitis. Both of these conditions involve obstruction of small airways deep in the lung because of various combinations of mucus, edema, and bronchospasm (Figure 3-7). Differentiation between these two common conditions is of little importance because they are

Figure 3-5 Epiglottitis is a bacterial infection of the trachea.

28

treated the same in the field setting. Foreign body aspiration as a cause of wheezing can usually, but not always, be differentiated from asthma and bronchiolitis by its sudden onset without previous illness. Unilateral wheezing, on the other hand, is not helpful as one might first expect. Many children with asthma have more wheezing in one lung than the other.

The differential diagnoses of rhonchi and tales will not be discussed because the field management of all respiratory illnesses manifesting these symptoms in pediatric patients is essentially the same.

MANAGEMENT DURING TRANSPORT?

For all children in respiratory distress there are four components of management that are always the same, regardless of the possible diagnoses:

1. Offer oxygen if tolerated.
2. Keep the child calm.
3. Position the child appropriately.
4. Begin positive pressure ventilation for apnea, gasping, or cyanosis despite oxygen.

In fact, for respiratory distress not associated with obstruction, these are the only four therapies available to the EMT. Even for most children with airway obstruction the same four therapies will usually be all that is needed for safe transport. However, if a child is in great distress—indicated by severe retracting, marked change in behavior, or cyanosis—and if the child is strongly suspected of having foreign body aspiration, croup, epiglottitis, or asthma, then specific additional therapy may be warranted.

Figure 3-8 EMTs prepare to transport a pediatric patient with mild respiratory distress.

A child suffering from foreign body aspiration causing stridor should be subjected to airway clearing maneuvers only if the airway obstruction is so severe that cyanosis is present. The specific airway clearing maneuvers for children of different ages will be discussed in Chapter 5. A foreign body causing wheezing will almost never require emergency airway clearing maneuvers. To be causing wheezing, the foreign body is most likely sufficiently far down in the bronchial tree that only one lung is being obstructed. The remaining lung will provide sufficient air exchange to prevent frank cyanosis.

A child suffering from croup who is in marked distress will benefit from cool air. Simply taking this child outside into the cool night air (croup usually occurs or worsens at night) or cooling the rescue vehicle may be of great benefit to the child. Remember to avoid agitating the child in the process. If this does not bring about sufficient relief then, under the direction of medical control, an aerosol of racemic epinephrine (Micronephrine 0.3 ml in 2 ml of normal saline) will often result in dramatic improvement. Recent data suggests that epinephrine given as an aerosol is as effective as racemic epinephrine. Again, if the aerosol causes extreme agitation it should be discontinued. The aerosol's other risk is dysrhythmia—an unlikely event if the aerosol is given with oxygen. Nevertheless, the application of a monitor would be desirable if
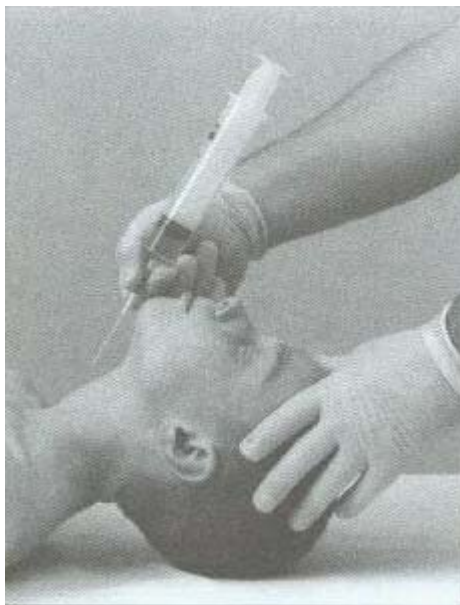
Figure 3-9 Placement of a needle cricothyroidotomy.

Figure 3-10 Needle cricothyroidotomy set up 14 gauge catheter over needle, adapter from a 3.0 mm endotracheal tube with stem cut with a scissors to a length that inserts snugly into the catheter, resuscitation bag.

tolerated by the child. Also, if there is any suspicion of epiglottitis (for example, a history of high fever) then an aerosol should not be tried. It may precipitate airway obstruction in the child.

When epiglottitis is suspected and the child develops cyanosis, positive pressure ventilation should be tried first with a bag and mask. Surprisingly, this is successful up to 50 percent of the time in children with epiglottitis. If it is not effective and intubation has failed, the only hope for the child may be needle cricothyroidotomy (a very difficult procedure in the pediatric patient). The procedure is performed with a 14 g or 16 g angiocath placed in the cricothyroid notch and angled slightly toward the child's feet (Figure 3-9). By attaching the angiocath directly to an oxygen source, via IV tubing linked to oxygen tubing for 1-2 second intervals, oxygenation may be maintained for the duration of the transport (Figure 3-10). Finally, a severe asthmatic attack can be relieved with either subcutaneous epinephrine (0.01 ml/kg of 1:1000 to a maximum of 0.3 ml) or aerosol therapy. Aerosol therapy has the advantage of being less painful and, for most but not all children, producing less agitation. An effective aerosol for childhood asthma is Albuterol in a dose of 0.5 ml in 2 ml of a normal saline solution. The risk of these medications is dysrhythmia. This risk is small but increases with hypoxia. Therefore, they should be used with oxygen. Albuterol may be used continuously in transport if necessary. As a final point, it is worth noting that, unlike croup, asthma is worsened by cool air.

EXAMPLES

The following three examples illustrate the stepwise approach to the evaluation and management of a pediatric patient in respiratory distress as presented in this chapter. The reader should read each example and then answer the five questions discussed previously before reading the answers given below each example.

EXAMPLE 1

A 4-month-old infant with a one-day history of cold symptoms develops labored breathing. On arrival the infant is limp, has moderate retracting, and has a respiratory rate of 50. She is pale but not cyanotic. Auscultation reveals coarse rales. Peripheral pulses are strong.

Severity?   Moderate to severe
Position?   Air sniffing
Oxygen? PPV? 3 liters by nasal cannula or 6 liters by partial rebreathing mask
Obstruction?   None
Management?   Continue the above, plus positive-pressure ventilation if apnea, gasping, or cyanosis
                        develops; monitor; rapid transport
NOTE: The respiratory rate of 50 is mildly reassuring. If the respiratory rate were 25, PPV would be advisable.

EXAMPLE 2

A 16-year-old asthmatic girl has been wheezing all day. She took several aerosols just prior to the arrival of EMTs. On arrival the girl is alert, talkative, denying the need for transport. Her respiratory rate is 24. Color is good. There is mild retracting. There are moderate wheezes on auscultation.

Severity?   Mild to moderate at this time but may have been worse prior to the home aerosol therapy
Position?   As she chooses
Oxygen? PPV? High flow by non-rebreathing mask (6 to 10 liters)
Obstruction?   Yes, lower airway, probably asthma
Management?   Continue the above, plus rapid transport; warm the transport vehicle; no bronchodilators
                        necessary during transport unless retracting increases

EXAMPLE 3

A 4-year-old boy with rapid onset of labored breathing associated with high fever and sore throat is to be transported. On arrival the boy has a respiratory rate of 20 and is leaning forward with moderate retracting. Color is good. Pulse is 140 and strong. He appears anxious. There is low-pitched audible stridor.

Severity?   Moderate to severe
Position?   As he chooses
Oxygen? PPV? High flow mask if tolerated
Obstruction?   Yes, epiglottitis likely
Management?   Continue the above; prepare bag-mask, endotracheal tube, and needle cricothyroidotomy;
                        rapid transport to appropriate facility

SUMMARY OF KEY POINTS

1. The respiratory system represents to pediatric emergency care what the cardiovascular system represents to adult emergency care: the major source of life-threatening illness.
2. A pediatric patient in respiratory distress should be evaluated and managed according to the following sequence of priorities:
    a. Quick assessment of severity based on behavior and retracting.
    b. Quick judgement regarding optimal positioning during assessment and management.
    c. Provision of oxygen if it does not result in agitation; provision of positive-pressure ventilation if there is apnea, gasping, or cyanosis.
    d. Assessment of obstruction using breath sounds.
    e. A decision regarding the need for additional therapy beyond those used for all children in respiratory distress—calming, oxygen, positioning, positive-pressure ventilation if needed; the decision is based on the presence of obstruction.
3. Aerosol therapy is very effective field therapy for both croup (racemic epinephrine) and asthma (Albuterol), but is dangerous when epiglottitis is suspected.
4. Cool air helps croup but aggravates asthma.
5. Stridor is loudest on inspiration. It represents upper airway obstruction—usually croup, occasionally epiglottitis or foreign body.
6. Wheezing is loudest on expiration. It usually represents asthma or bronchiolitis; occasionally it represents foreign body aspiration.

Chapter 4

Shock
OBJECTIVES

1. From a list, select the likely etiologies of shock in pediatric patients.
2. Given the list of assessment parameters, identify those most useful in the evaluation of shock.
3. Given the list of alternatives to conventional IV access, identify the appropriateness of each alternative.
4. Select from a list the appropriate fluid bolus for pediatric patients in various age groups with shock of varying etiology.
5. Given a list of statements regarding shock in pediatric patients, identify whether each statement is true or false.

After respiratory distress, shock is the most frequent causative factor for cardiopulmonary arrest in the pediatric patient. Shock in the pediatric patient should be regarded as a load-and-go situation. This chapter will review the causes of shock in children and the justification for a load-and-go approach.

DEFINITION

Shock is a misused medical term. Laymen often use the term to mean a mental state of decreased responsiveness resulting from a sudden unexpected occurrence. ("She is in a state of shock after witnessing the accident.") Medical personnel often use the term interchangeably with the term low blood pressure (hypotension). What is the medical definition of shock?

Shock is insufficient blood flow to body tissues. Shock is not an altered mental status, although an altered mental status often accompanies shock. Shock is not equivalent to hypotension. Blood pressure results from the combination of blood flow pushing against resistance to blood flow. This resistance to blood flow takes place in millions of arteries and veins. Mathematically this is expressed as follows:

Blood pressure = Blood flow x Resistance

It is easy to see that blood pressure can be normal even when blood flow is decreased (shock) if the resistance to flow is high. In children this is a frequent occurrence. For example, a child who has lost blood as a result of trauma will have decreased blood flow. However, the child's arteries and veins will constrict, resulting in high resistance to flow. Hence blood pressure, the product of flow multiplied by resistance, is maintained. The child's ability to constrict arteries and veins is much better than that of the adult. As a result, a normal or near normal blood pressure in the face of decreased blood flow is a much more common occurrence in pediatric patients than in adult patients. Implications for assessment, given that a normal blood pressure does not rule out shock, will be discussed later. However, the fact that children are better able to maintain blood pressure in the face of blood loss supports a load-and-go

approach to shock in children. Children are more likely to maintain their blood pressure during transport without the help of specific fluid or drug therapy.

ASSESSMENT

There are other difficulties with relying exclusively on blood pressure to assess a child's circulation. Taking a child's blood pressure is technically more difficult than taking an adult's blood pressure. First, the proper size cuff varies with age, necessitating that a rescue vehicle carry three or four blood pressure cuffs of different sizes. Second, the sounds one listens for are more difficult to hear because they are softer and the child is often uncooperative. Finally, normal blood pressure varies with age, requiring that medical personnel be familiar with normal pressures for different ages in order to properly interpret a blood pressure reading (see Table 4-1). In summary, when assessing a child's circulation, the blood pressure is of limited value. If the proper cuff size is available, a blood pressure should be taken for use as a baseline and then repeated periodically to identify significant trends. However, the judgement regarding the presence or absence of shock in a child should be based on other parameters in addition to the child's blood pressure.

What are the most useful parameters when assessing a child's circulation? The strength of the peripheral pulses and capillary refill time are the best indicators of a child's circulatory status in the field. An infant or a child with an easily palpable radial pulse and a capillary refill time of less than 2 seconds probably has an adequate circulatory status. Conversely, if a radial pulse is weak and thready and capillary refill time approaches 5 seconds, shock can be assumed to be present. When assessing these signs it is also useful to note the appearance of the skin. A mottled appearance, or uneven coloration of the skin, further confirms the presence of shock. However, in the field situation mottling of the skin may be difficult to recognize. Pallor and skin that is cool and clammy to the touch would further support the assessment that circulation is poor.

Heart rate is, of course, another parameter that can give an indication of circulatory status. However, in the pediatric age group, heart rate, like blood pressure, has several limitations when used to assess circulation. The heart rate of a pediatric patient varies greatly with age (Table 4-1), body temperature, and degree of agitation. Nevertheless, marked tachycardia in the quiet infant or child without fever is also strong evidence of shock. Finally, extreme lethargy would further support the assessment that circulation is poor.

CAUSES OF SHOCK IN PEDIATRIC PATIENTS

Table 4-1 compares the distribution of types of shock in adult and pediatric patients. As Table 4-1 illustrates, shock in the adult patient is frequently secondary to a primary heart problem: dysrhythmia, congestive heart failure, or coronary artery disease. In the pediatric patient, on the other hand, primary cardiac dysfunction is rare (exception: known congenital heart disease). Shock in the pediatric patient is almost always secondary to an intravascular volume problem—either volume has been lost (dehydration, hemorrhage) or maldistributed (sepsis, anaphylaxis). This difference greatly simplifies the treatment of shock in children in the pre-hospital setting.

TABLE 4-1 DISTRIBUTION OF TYPES OF SHOCK

Type	Pediatric	Adult
Hypovolemic	+++	++
Distributive	++	+
Cardiogenic	Rare	+++

MANAGEMENT

The therapy for shock in the pediatric patient is directed toward expansion of the vascular volume, constriction of the vascular space, or both. Expansion of vascular volume is accomplished in the field with a rapid initial fluid bolus of 20 ml/kg of normal saline or Ringer's lactate. Normal saline or Ringer's lactate is used for pediatric patients just as it is for adult patients when the goal is expansion of vascular volume. These fluids stay in the vascular space after they are infused. Fluids with less salt content, such as 5 percent dextrose in 1/4 normal saline, a frequently used maintenance solution in pediatric patients, quickly leak out of the vascular space after being infused and are, therefore, much less effective as volume expanders. In pediatrics a fluid bolus may be given very rapidly: over 5 minutes or less! Rapid fluid bolus is relatively safe in pediatric patients because a child's cardiovascular system can accept fluid rapidly without the development of pulmonary edema. The initial bolus is just that. It is the first step in fluid resuscitation. It should be repeated if (1) there is some response (improved color and capillary refill time, decreased heart rate) but the circulation is still not adequate, or (2) there is no response, but fluid loss has obviously been severe. The difficulty with IV fluid therapy for shock in the pediatric patient is gaining IV access. This is a major problem in the emergency room setting as well as in the pre-hospital setting, particularly in the dehydrated infant.
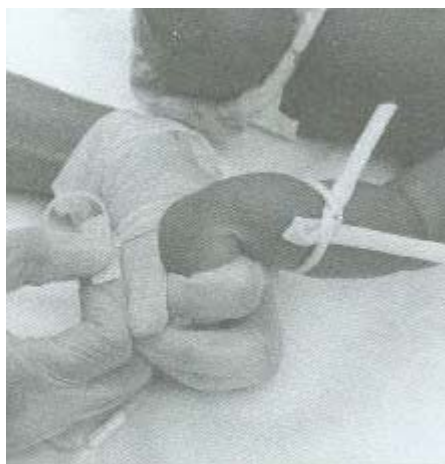

Figure 4-1 Butterfly IV needle being placed in a child's hand. Though an IV line established with a butterfly is much less stable than a catheter IV it may permit one rapid lifesaving bolus of fluid. Butterfly Ivs are often lost when the patient is moved. The best policy is to load-and-go, starting the butterfly just after loading the child.

For purposes of fluid resuscitation, IV access should be established in the largest accessible vessel in the hand, arm, or foot. If after quick inspection of possible IV sites the EMT determines that gaining IV access will be difficult, he has three options. The first, and usually the best option, is load-and-go.

The second alternative when IV access appears difficult is a brief attempt at gaining IV access with the simplest method possible, namely, a butterfly needle (Figure 4-1). Sites for placement of the butterfly needle are the same as those mentioned previously.

The third alternative is the placement of an intraosseous needle (a needle into the bone marrow) if local protocol permits (Figure 4-2). A special needle is required (Figure 4-3). It must be a heavy gauge (15 gauge) so that it does not bend, and it must contain a stylet so that particles of bone do not occlude the lumen of the needle during placement. It is placed in the tibia just below the knee on the medial aspect of the leg. IV tubing is attached directly to the needle

and fluid is pushed in a fashion similar to that of fluid pushed through a regular IV line. The marrow offers variable resistance to the infusion of fluid. Therefore, it will occasionally be necessary to place a stopcock and syringe in the line to enable the EMT to apply sufficient pressure to overcome the marrow s resistance (Figure 4-4). This technique should be used only in desperate situations where shock is severe and transport time is long. For example, this technique may be used with a pediatric trauma victim with absent pulses who is more than 15 minutes from the nearest hospital.
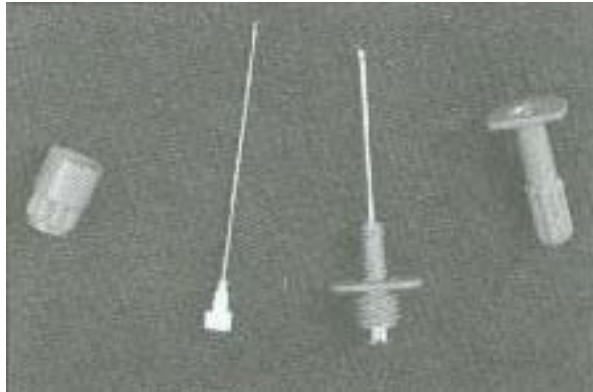

Figure 4-3 Intraosseous needle. The stylet prevents bone fragments from obstructing the needle lumen during placement.
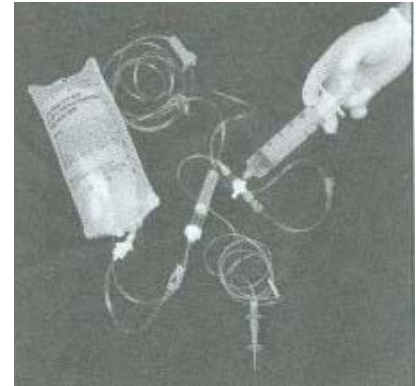
Figure 4-4 Use of a 3-way stopcock and syringe to allow boluses of fluid through an intraosseous line.

Theoretically the intraosseous infusion may be used for any patient in whom the red marrow space can be accessed, however it is recommended for patients 6 years old or less. Intraosseous cannulation becomes progressively more difficult as the patient's age increases.

One disadvantage of intraosseous infusion is that the rapid delivery of a fluid bolus can be difficult because of high resistance to flow. Osteomyelitis (bone infection) is a potential complication of the procedure. However, this is of secondary importance when the situation is desperate.

AN EXCEPTION

Although volume therapy will benefit the vast majority of pediatric patients in shock in the pre-hospital setting, one exception to this rule is the child who is in a post-arrest state from a cause other than volume loss. Infants and children who have arrested because of SIDS, drowning, or primary respiratory arrest, for example, will not be volume depleted. If these children are in shock after cardiopulmonary resuscitation, then the most likely explanation is that the heart was without oxygen for a prolonged period of time. To improve the heart's pumping action in this setting may be impossible. However, a continuous infusion of a drug such as dopamine might provide some benefit. To quickly mix a dopamine infusion without laborious calculations and the risk of substantial mathematical error, the EMT should simply add 60 mg of dopamine to 100 ml of D5W and run the infusion at 1 to 2 ml/kg/hr. For example, if the child weighs 20kg, 60 mg of dopamine added to 100 ml of fluid is run at 20-40 ml/hour (kilogram weight is determined by estimating weight in pounds and dividing by 2). This yields an infusion rate of 10 to 20 mg/kg/mm. Again, excessive time should not be taken to institute the dopamine infusion at the scene. This should be regarded as an en route procedure used primarily when transport time is long.

SUMMARY OF KEY POINTS

1. Shock in pediatric patients is most often secondary to volume loss or maldistribution of circulatory volume. Cardiogenic shock (shock resulting from a primary cardiac problem) is rare in pediatric patients. It occurs primarily in the pediatric patient who has suffered a complete cardiopulmonary arrest.
2. Peripheral pulses and capillary refill time are the most reliable parameters for assessing a child's circulation.
3. Blood pressure and heart rate vary with age, fever, and anxiety. They should be assessed to establish baseline values. However, when used without reference to peripheral pulse strength and capillary refill time, they can lead to an incorrect judgement regarding the presence or absence of shock in a child.
4. Volume therapy or constriction of the vascular space (dopamine) are the principal emergency therapies for the pediatric patient in shock.
5. IV access in the pediatric patient is difficult. Excessive time should not be spent at the scene attempting this difficult maneuver. Rapid transport and a butterfly IV en route are the keys to optimal field therapy for shock in the pediatric patient when 2-3 attempts at a catheter IV have failed. Intraosseous infusion may be appropriate in selected circumstances when local protocol permits.
6. In the post-arrest pediatric patient in shock, dopamine may improve blood flow and blood pressure.
7. Shock in the pediatric patient is a load-and-go situation. Difficult IV access makes fluid field therapy problematic. Furthermore, the child's ability to maintain blood pressure in the face of decreased blood flow decreases the necessity for field therapy.

Chapter 5

Altered Level of Consciousness

OBJECTIVES

1. Given a list of signs, symptoms, historical and environmental cues, determine the most likely etiology of altered mental status in the pediatric patient.
2. From a list of alternatives, select the proper priority sequence for managing altered mental status in the pediatric patient.
3. Given a list of poisonous substances and a list of antidotes, match the poison to its antidote.
4. Given a patient with AMS of identifiable etiology, select the appropriate management strategies.
5. Using the acronym AEIOU-TIPS, list nine causes of an altered mental status.

When managing a child with an altered level of consciousness, the initial priorities are no different than when presented with any other emergency situation: airway, breathing, and circulation (ABCs). Once these priorities have been assessed and managed as necessary, the next step is to accurately grade the degree of alteration in consciousness using the Glasgow Coma Scale (GCS). The final step is to look for the specific cause of the altered level of consciousness, focusing particularly on those causes for which specific field therapy could be life saving. This sequence—ABCs, GCS, cause—is not necessarily easy to adhere to. For example, one is easily distracted by the altered level of consciousness into considering possible causes before assessing the ABCs. Just as it requires discipline to focus initially on the ABCs in the multiple trauma victim with an open femur fracture, it also requires discipline to systematically assess the ABCs of the comatose child before giving much, if any, consideration to the reason for the child's comatose state.

AIRWAY

The airway of a child with an altered level of consciousness is particularly vulnerable because of depressed gag, cough, and laryngospastic reflexes. Management is similar to the airway management employed during cardiopulmonary resuscitation (CPR) (see Chapter 6). Breath sounds provide the key to assessment. If stridorous or snoring sounds are present, the most likely cause is the child's tongue resting against the posterior pharynx and soft palate. The chin-lift and jaw-thrust maneuvers are reliable methods of opening the tongue-occluded airway. Oral airways and nasopharyngeal airways are best avoided in the lightly comatose pediatric patient because of the risk of inducing vomiting if the gag reflex is still present. Suction should be prepared and used if there are audible upper airway rhonchi or other evidence of fluid in the upper airway. If vomiting does occur, the child should be quickly turned and the oropharynx suctioned. Finally, if transport time is long and the gag reflex is absent, consideration should be given to elective intubation to protect the airway from aspiration.

BREATHING

Breathing should be routinely supported with high-concentration oxygen. The child with an altered level of consciousness will frequently hypoventilate, even when color and respiratory rate are thought to be normal. If the patient is breathing 100 percent oxygen, blood oxygenation is likely to be maintained in the face of hypoventilation. If the child's color is dusky despite mask oxygen, positive-pressure ventilation with bag and mask must be initiated, followed by intubation and bag-to-tube ventilation to protect the child from aspiration. Mild hyperventilation of the comatose child will usually be appropriate to compensate for the patient's earlier hypoventilation or as therapy for suspected increased intracranial pressure, a complication associated with several causes of a depressed level of consciousness in a child.

CIRCULATION

Circulation assessment and shock management in the comatose pediatric patient are discussed in Chapter three.

ASSESSING LEVEL OF CONSCIOUSNESS

After the child's ABCs have been assessed and managed, the next step is to grade the child's level of consciousness. Accurate grading will permit the early recognition of subtle changes in consciousness level. Such changes have important implications for therapy.

A child's level of consciousness is assessed in a fashion similar to that of an adult, eye opening and verbal and motor responses to stimuli (GCS). However, when dealing with nonverbal infants and small children, the numbering system of the GCS is less meaningful than for older patients. In particular, the nonverbal, non-obedient infant cannot score higher than 13 (range 3 to 15) even when fully alert. To deal with this problem the GCS has been modified for infants (Table 5-1). However, rather than learn another scoring system, the EMT should simply apply two standard stimuli (calling the infant's name loudly and pinching her toe) and then note the infant's responses. These responses should be accurately recorded in the trip report and related to the receiving physician. For example, "There was no response to calling the infant's name. In response to pinching the child's toe, there was a weak, brief cry and purposeful withdrawal of the foot but no eye opening." Periodically during transport these same stimuli should be repeated and the child's responses noted. Deterioration in the child's level of consciousness should prompt reassessment of the ABCs and review of potential causes of the child's altered level of consciousness. A call to base station medical control is also indicated.

CAUSES OF AN ALTERED LEVEL OF CONSCIOUSNESS

Although maintaining vital functions rather than making a specific diagnosis is the primary objective of pre-hospital care, considering possible causes of a child's altered level of consciousness may be critical to maintaining a child's vital functions. A quick means of reviewing possible causes of a child's altered level of consciousness is the use of the acronym AEIOU-TIPS (Table 5-1).

A stands for alcohol, a consideration as a causative or complicating factor in any adolescent with an altered level of consciousness. Smelling the adolescent's breath will usually rule in or out this diagnosis.

E stands for encephalitis and meningitis. A history of a fever or the finding of a stiff neck on examination would be suggestive of these diagnoses. Because there is no specific therapy for these central nervous system infections in the field, the major benefit of the time spent evaluating an infant or child for these diagnoses would be to institute appropriate infection control procedures.

I represents insulin, a reminder of two diagnoses for which specific field therapy might be critical: hypoglycemia and diabetic ketoacidosis. A Chemstrip finding of less than 50 should be taken as strong evidence of hypoglycemia. Treatment with 1 ml/kg of D5OW by IV bolus, or 2 ml/kg of D1OW for an infant less than 3 months of age, followed by a continuous infusion of D1OW at *5* ml/kg/hour would be in order. [D10.8N5 may be made by mixing 2 ml of D5OW with 8 ml of normal saline (NS)]. During long transports the Chemstrip test should be repeated every 15 minutes. A Chemstrip finding over 200, associated with a fruity odor to the breath and hyperventilation, should be taken as strong evidence of diabetic ketoacidosis.

Therapy in the field consists of 20 ml/kg NS over 10 minutes followed by additional fluid as ordered by base station medical control. (Note that the use of saline, or Ringer's lactate, rather than hypotonic fluids such as 5 percent dextrose in 1/2 or 1/4 normal saline is critical. Hypotonic fluid boluses in childhood diabetic ketoacidosis increase the risk of cerebral edema and increased intracranial pressure in these children.) Bicarbonate therapy for a child in diabetic ketoacidosis also carries some risk. Therefore, in the field setting the child with diabetic ketoacidosis should be treated with saline and general supportive care.

TABLE 5-1 CAUSES OF ALTERED MENTAL STATUS

Condition	Observations	Therapy
A-Alcohol (adolescent)	Smell breath; assess environment	Check and treat other injuries obscured by the inebriated state
E-Encephalitis, Meningitis	History of fever; stiff neck	None for the patient; infection control procedures
*I-Insulin	Chemstrip, dehydration	1 ml/kg of D50W if finding is less than 50 (2 ml/kg of D10W if age <3 months)
*O-Opiates and other ingestants (age 1-4 and adolescents)	Environment, clothes, pupils, drugs/medications in the home	Naloxone, oxygen, diphenhydramine, and atropine are possible antidotes
*U-Uremia, hypoxia, hypotension, hyperthermia, hypothermia	Evaluation of ABC's; assess skin temperature; if very warm or cold, assess rectal temperature	Cooling/warming; management of the ABC's
*T-Trauma	Assess for increased intracranial pressure (ICP)	Hyperventilate if increased ICP is suspected and respiratory support is necessary; elevate head if not in shock
I-Infection (sepsis)	Rash, fever	Fluid bolus for shock
P-Psychiatric (adolescent)	Smelling salts	Do not announce diagnosis
*S-Seizure	Check eyes, tone	Protect airway, oxygen; Phenobarbital or diazepam, if necessary, to facilitate airway control; Chemstrip

* Field therapy may be critical

O stands for overdose, opiates and other poisonings. There are two situations in which poisonings should readily be suspected: (1) when there is a sudden onset of altered level of consciousness without any history of fever or trauma in a toddler between 1 and 4 years of age, and (2) when an emergency involves an adolescent or older child with a past history of drug abuse or adjustment problems. In general, when poisoning is suspected, there are only two therapeutic modalities to consider in the field beyond the ABCs: induction of vomiting and administration of antidotes. However, induction of vomiting in a child with an altered level of consciousness is contraindicated because of the risk of aspiration. If the patient is alert, the local poison control center should be consulted for advice. Induction of vomiting may still be contraindicated in such a patient if the poison is a corrosive or a hydrocarbon. Also, for many poisonings, the administration of activated charcoal (1 g/kg) is now preferred to the induction of vomiting.

Antidotes are of less use in the management of poisoning than is popularly believed. However, five antidotes that should be familiar to every EMT are (1) oxygen for carbon monoxide poisoning; (2) atropine for insecticide poisoning; (3) diphenhydramine (Benadryl) for a phenothiazine reaction (a posturing reaction similar to seizure activity without loss of consciousness); (4) Naloxone (Narcan) for opiate overdose, and (5) bicarbonate for tricyclic antidepressant poisoning. Opiate overdose should be suspected in the adolescent or older child with constricted pupils and slow, shallow respirations. Dosages of each of these antidotes are listed in Table 5-2 and bicarbonate for tricyclic antidepressant overdose. Another important aspect of field management of poisoning is to transport all remaining potential poisons, including empty containers, for analysis by the treating physicians and the hospital laboratory. Finally, the following is a list of particularly dangerous poisons that are common in children and require rapid transport and careful monitoring: camphor, antidepressant medications, amphetamines, digitalis, nitrites, iron, aspirin, acetaminophen, methyl alcohol and ethylene glycol.

TABLE 5-2 ANTIDOTES

Poisoning	Antidotes
Carbon monoxide	100% Oxygen
Organophosphate insecticides	Atropine 0.05 mg/kg IV repeated as needed
Phenothiazines [for example, chlorpromazine (Thorazine), prochlorperazine (Campazine)]	Diphenhydramine 1 mg/kg IV
Opiates	Naloxone (Narcan) 0.01mg/kg IV, repeated at 0.1 mg/kg to a maximum dose of 2 mg as needed
Tricyclic antidepressants	Sodium bicarbonate 1 meq/kg by slow push

U stands for uremia (kidney failure) and other organ system failures. There are no field therapies available for most of these diagnoses beyond supportive care of the child's ABCs and rapid transport. One exception is extreme alteration in body temperature: hyperthermia or hypothermia. The child with a rectal temperature over 106.5 F secondary to a hot environment (not infection) should be rapidly cooled with exposure, sponging, fanning, and ice packs. The child with a rectal temperature less than 95 F should be rewarmed en route with blankets.

T stands for trauma or, more specifically in the traumatized child with stable ABCs, head trauma. Obvious external signs, unequal pupils, or a firm fontanel suggests head trauma. More specifically,

unequal pupils, a firm fontanel, the presence of posturing, or the combination of hypertension and bradycardia indicate increased intracranial pressure (ICP) and the need for specific field therapy to address this common complication (see box below). If shock is not present, elevation of the head and upper torso to 30 degrees and fluid restriction are the first steps in the treatment of suspected increased ICP in a child. The most definitive therapy is hyperventilation. However, hyperventilation is best accomplished after the child is intubated, and intubation carries risks in the child with increased ICP. One such risk is a possible neck injury if an unstable cervical spine fracture is present. In addition, the process of intubation may actually increase ICP if gagging, vomiting, or hypoventilation occur. Therefore, intubation and hyperventilation of the traumatized child should be reserved for situations in which intubation is needed for airway control or the child's level of consciousness is rapidly deteriorating. Hyperventilation by bag-mask-valve is another alternative, though it carries the risk of vomiting and aspiration.

Signs of Increased Intracranial Pressure

Depressed level of consciousness
Firm fontanel
Pupillary abnormalities (unequal, constricted, dilated)
Posturing (see Figure 8-1)
Hypertension and bradycardia

No one of these findings is absolutely diagnostic of increased intracranial pressure. However, in a clinical setting in which the possibility of increased intracranial pressure is suggested (for example with head trauma), the presence of a depressed level of consciousness plus one additional sign can be taken as strong evidence for increased ICP.

Another option is Mannitol 0.5 gm/kg intravenously. However, this therapy also carries risks. First, Mannitol will initially increase ICP because it acts first as a fluid bolus before its other effects act to lower ICP. This can be counteracted with the simultaneous administration of Furosemide (Lasix) 1 mg/kg. However, both of these drugs, particularly when used together, carry the risk of hypotension in a child with blood loss resulting from trauma. Avoiding this complication has greater priority in the field than treating increased JCP. Therefore, these drugs should be used with caution.

In summary, when increased ICP is suspected, base station medical control should be consulted regarding the relative risk of intubation and hyperventilation versus administration of Mannitol and Furosemide. If the airway is unstable and there is risk of significant bleeding from—for example, a ruptured spleen—intubation and hyperventilation is preferable. If there is great suspicion of cervical spine injury but excellent peripheral perfusion and little suspicion of a large blood loss, administration of Mannitol and Furosemide is preferable.

I stands for overwhelming infection, that is, sepsis or septic shock. This diagnosis will be apparent from the initial analysis of the child's ABCs. Additional clues would be the history of fever or the presence of petechiae or purpurea, a red or blue rash that does not blanch with pressure.

P stands for psychiatric conditions presenting as an altered level of consciousness. Adolescents account for most of the pediatric patients in this category. These patients can demonstrate the full spectrum of altered level of consciousness from bizarre activity to apparent coma. The apparent coma is most easily distinguished from true coma by various challenge tests. For example, lightly stroking the eyelid will evoke a blink response in a patient who is not truly comatose. Smelling salts will also promptly "revive" the adolescent with psychogenic coma. Failure to diagnose this condition in the field is, of course, no tragedy since no specific field therapy is required. On the other hand, if the diagnosis is made in the field, transport is still indicated. Furthermore, it is inappropriate to discuss the diagnosis with family members. An adolescent who goes to such an extreme is troubled, to say the least. The therapeutic goal in this situation is to offer the adolescent understanding rather than cause her embarrassment in front of her family.

S stands for seizures. One in twenty children under the age of 5 will have at least one seizure resulting from high fever. Fortunately, most of these will stop in a few minutes and do no harm to the child. A few may be prolonged. A child may also seize from meningitis, poisoning, trauma and an inherited or acquired tendency to seizures (epilepsy). The important point for the EMT to appreciate about the diagnosis of seizure activity in pediatric patients is that it is often very subtle. Particularly in infants it may be extremely difficult to decide if there is ongoing seizure activity or just a depressed level of consciousness from a post-ictal (post-seizure) state or some other cause. The typical tonic-clonic movements may be absent. Careful examination of the eyes for tonic deviation or jerking and examination of the extremities for increased muscle tone or unequal muscle tone may be helpful. It is also important to make these and other observations on a patient with obvious seizure activity, not only to treat the patient appropriately in the field, but also because this information on the nature and duration of the patient's seizures will be useful to the receiving emergency room physician.

If a pediatric patient is seizing, the first priorities are airway and breathing. Suction should be readied; high-concentration oxygen should be provided; and preparations should be made to provide positive pressure ventilation if the patient becomes apneic or cyanotic. Anticonvulsant use in the field is controversial. If the infant or child appears well ventilated and the transport distance is short, anticonvulsants are not indicated. If there is cyanosis despite oxygen therapy, medical control should be contacted if local protocol permits the use of anticonvulsants. Diazepam (Valium) is probably the drug of choice in the field at a dose of 0.2 mg/kg IV delivered very slowly. The same dose may also be administered via the rectal route. Some protocols might call for IV phenobarbital 10 mg/kg (maximum 300 mg). Both drugs carry the risk of apnea. Hence, neither should be administered unless the EMTs involved are ready to provide and are comfortable with the technique of positive-pressure ventilation in children.

A Chemstrip test should be performed on all seizing children prior to anticonvulsant therapy. If the glucose is less than 50, then D10W or D50W, as discussed earlier, should be administered instead of an anticonvulsant. If fever is suspected as the cause of the seizure, then the child should be cooled with exposure and sponging en route. Sponging at the scene is not warranted. It will not influence the duration of the seizure. Similarly, sponging should not take the place of anticonvulsant therapy if the latter is

indicated because of length of transport or the status of the child's airway or ventilation.
AEIOU-TIPS:
THE FIELD PRIORITIES

As noted above, not all of the diagnoses represented by the acronym AEIOU-TIPS must be made in the field setting. On the other hand, some of these diagnoses do need to be made if proper therapy is to be rendered. These diagnoses include I-hypoglycemia; O-opiates, carbon monoxide, insecticides, tricyclic antidepressants and phenothizines; U-hyperthermia; T-head trauma with increased intracranial pressure; and S-seizures. Consequently, after assessing and managing the ABCs and grading the child's level of consciousness, the EMTs should consider proceeding with the following:

1. Chemstrip test
2. Poisoning history
3. Trial of Narcan
4. Evaluation of skin temperature
5. Examination for signs of head trauma and increased intracranial pressure
6. Examination of the eyes and muscle tone to detect subtle seizure activity

Additional treatment depends on the results of the above assessments.

SUMMARY OF KEY POINTS

1. The sequence of priorities when managing a child with an altered level of consciousness is the following:
   a. Assess ABCs.
   b. Grade level of consciousness.
   c. Assess for the cause of altered level of consciousness.
2. The airway of a comatose child is vulnerable because of depressed gag, cough, and laryngospastic reflexes. An oral airway should be avoided if possible.
3. Children with a depressed level of consciousness frequently hypoventilate. This hypoventilation can be difficult to appreciate clinically. Consequently, high-concentration oxygen by mask is indicated for all such patients.
4. The level of consciousness should be repeatedly graded by noting the child's verbal, eye and motor responses to standard verbal and painful stimuli.
5. A convenient method of remembering a number of possible causes of a child's altered level of consciousness is the acronym AEJOU-TIPS. Diagnoses that may require emergency field therapy include hypoglycemia, ingestion, head trauma and seizures.
6. Head trauma with suspected increased intracranial pressure is treated with hyperventilation provided that intubation can be carried out swiftly. Bag-mask-valve hyperventilation is a less desirable alternative.
7. Seizures in infants may be very subtle.
8. Not all sustained seizure activity requires anticonvulsant therapy in the field. Color, breath sounds and length of transport are the parameters that must be considered when determining the need for anticonvulsant therapy. Base station medical control should be consulted.

Chapter 6

Pediatric Cardiopulmonary Resuscitation

OBJECTIVES

1. Select from a list the prodromes to cardiac arrest in pediatric patients and determine the truthfulness of any statement regarding these prodromes.
2. Identify the single most critical step in the resuscitation of pediatric patients and select the parameter(s) that best indicate(s) adequacy of management of that step.
3. Select from a list the most appropriate means of determining proper ET tube size, proper means of ET intubation, and proper assessment of tube placement.
4. Given a list of patients of various age groups and with various pulse rates, determine the appropriateness of initiating CPR.

The driving force behind the rapid development of emergency medical services (EMS) systems in the United States during the 1970s was the recognition that the high rate of sudden cardiac death in the adult population could be reduced through the prompt delivery of emergency cardiopulmonary resuscitation (CPR). Accordingly, EMS systems were initially designed with the adult cardiac victim in mind. EMTs were primarily trained in cardiac resuscitation. Transport and communications systems were designed to deliver EMTs to the patient's side within minutes. Because most of the adult cardiac arrests were witnessed arrests, the lay public was, in turn, trained to begin basic CPR. This permitted lifesustaining cardiac output to be maintained during the critical minutes prior to arrival of an EMT with a defibrillator and antidysrhythmic medications.

For the adult cardiac victim, this system has worked well. Successful resuscitation rates as high as 30 percent have been documented for adults suffering out-of-hospital cardiopulmonary arrest. Unfortunately, the success rate for pre-hospital pediatric CPR has not been so impressive. Only 6.7 percent of children who experience cardiopulmonary arrest in the pre-hospital setting are discharged alive (Table 6-1). An even smaller percentage of these children are discharged neurologically intact.

Why are so few children successfully resuscitated in the prehospital setting? To answer this question one must look at the causes and circumstances surrounding out-of-hospital pediatric cardiopulmonary arrests.

TABLE 6-1 SUCCESS RATES FOR PEDIATRIC PRE-HOSPITAL RESUSCITATIONS

	Number	(%)
Basic EMT	1/17	(6%)
Advanced EMT	7/102	(7%)
Total	8/119	(6.7%)
Witnessed	5/33	(15%)

The large majority of pediatric cardiopulmonary arrests are unwitnessed respiratory arrests that progress after several minutes to complete cardiopulmonary arrest (Table 6-2). The classic example is the infant who experiences arrest as a result of sudden infant death syndrome (SIDS). This infant is thought to be well when put to sleep. For unknown reasons the infant stops breathing. The infant becomes tachycardic, then bradycardic. Extreme hypoxia and acidosis develop. Finally, asystole occurs. Several minutes or even hours later the infant is discovered by a parent. When the EMS rescue crew finally arrives, it is not surprising that they cannot resuscitate a heart that has been hypoxic and acidotic for a long time.

Even when a respiratory arrest is witnessed, but progresses to a complete cardiac arrest, such as an arrest caused by asthma, the condition might be expected to respond poorly to resuscitative measures. In such a case, the patient's heart will have been exposed to a prolonged period of hypoxia and acidosis prior to the development of asystole. Bystander CPR is not likely to be effective because of airway obstruction. The recovery potential of this patient's heart is much less than that of the adult coronary patient's heart, which has been reasonably well oxygenated prior to the sudden onset of ventricular fibrillation and which may remain partially oxygenated during bystander CPR.

TABLE 6-2 ETIOLOGY OF SUDDEN CARDIAC ARREST IN CHILDREN

	Number	(%)
SIDS	38/119	(32%)
Drowning	26/119	(22%)
Respiratory	11/119	(9%)
Neurological	5/119	(4%)
Congenital cardiac	5/119	(4%)
Other	34/119	(28%)

There are two other important implications of the differing nature of pediatric versus adult, out-of-hospital cardiopulmonary arrests. First, because respiratory failure is usually the precipitating cause, prompt restoration of adequate ventilation is more critical to success than antidysrhythmic therapy. Secondly, because pediatric cardiac arrest is nearly always a secondary response to hypoxia rather than an event resulting from primary cardiac disease, the dysrhythmias that occur during pediatric CPR are few and predictable.

Although the proper performance of CPR in any patient is one of the greatest challenges any medical professional will face, the EMT should approach pediatric CPR with the reassurance that many aspects of pediatric CPR are easier than the corresponding tasks for adult CPR. Opening the airway and ventilating the pediatric patient's lungs, for example, are easier and will sometimes be all that is necessary. Compressions are more easily performed. Few dysrhythmias occur. The list of antidysrhythmic drugs that must be mastered is much smaller. Finally, the most critical drugs may be administered via the endotracheal tube, if an IV line cannot be readily established on a pediatric patient in the field.

In summary, there are great differences between pediatric and adult out-of-hospital cardiopulmonary arrests. The EMT should regard pediatric CPR as a challenge that is different from, but not necessarily

more difficult than, adult CPR.

ASSESSMENT

The first step is to establish the need for CPR, or, in the terminology of advanced cardiac life support, to establish breathlessness. As in adults, this is accomplished by looking for chest rise and listening and feeling for air movement with the rescuers ear close to the child's mouth and her eyes directed at the child's chest. Because chest excursion and tidal volume values are lower in a child than in the adult, it is more difficult to establish breathlessness in an infant with certainty. This should not delay the next steps in CPR: positioning the patient on a hard surface, opening the airway, beginning assisted ventilation, and calling for help. A discussion of the techniques for opening the airway and assisting ventilation will follow this assessment discussion.

The next step in assessment is to check for pulses. This, too, may be more difficult in the infant or child. The brachial pulse site is recommended. If a brachial pulse is not palpable, or if the rate is less than 60 and the child is in shock, cardiac compressions should be started immediately. Valuable time should not be lost checking other anatomic sites for a pulse. Delaying compressions in a child with asystole carries greater risk than applying several rounds of compressions to the chest of a child with faint pulses that were not readily palpated. Also, it is not advisable to auscultate for heart sounds or palpate the chest to assess the need for compressions in an infant or child. The final determinant of the need for compressions is the effectiveness of the heart's pumping action on peripheral blood flow. This is determined by the presence of palpable pulses. Finally, even if a defibrillator is immediately available, it is not advisable to interrupt CPR for a quick look, as is recommended for adult CPR, because of the infrequent occurrence of ventricular fibrillation in the arrested pediatric patient.

AIRWAY

Manual airway maneuvers reliably open the airways of most pediatric patients. The first step is to position the head and neck in the "sniffing position" (see Chapter 3). This is accomplished by placing the child on a hard surface and rotating the head back so that the child's face is directed upward. This position is similar to that adopted when one is "smelling a rose". In the case of the trauma victim this maneuver must be carried out with in-line stabilization in order to protect a potentially unstable cervical spine from further injury. Furthermore, in the trauma victim the head should not be forcefully rotated. In this situation, gentle in-line stabilization in the neutral position is used and further manipulation is restricted to either the jaw-thrust or chin-lift maneuvers or insertion of an oral or endotracheal airway.

Despite proper positioning of the head, decreased tone in the muscles protecting the upper airway or a foreign body in the airway may still produce obstruction. The first problem can be relieved by the jaw-thrust or chin-lift maneuvers, the insertion of an oral airway, or the insertion of an endotracheal tube. The jaw thrust is performed by placing a finger behind the angle of the mandible on each side and exerting anterior pressure to lift the jaw. A chin lift is performed by placing a finger under the chin and lifting. Both of these maneuvers displace the mandible anteriorly and separate the tongue from the posterior pharyngeal wall. This also can be accomplished by inserting an oral airway. An oral airway is "sized" by placing it next to the child's cheek. The end of the airway should just reach the angle of the mandible

(Figure 6-1). Finally, an oral airway should only be placed in a child after the child's airway has been visually inspected for a foreign body. Otherwise, there is risk that the oral airway may push a foreign body deeper into the child's airway, making removal more difficult.

It is, in general, much easier to achieve and maintain a patent airway without intubation in an infant or child than in an adult. Nevertheless, intubation should be performed in a skilled and controlled fashion, in order to minimize the risk of aspiration and the complication of gastric distention with bag-valve-mask ventilation, particularly if prolonged ventilatory assistance is suspected to be necessary.

The actual technique of intubation is similar in adults and children, although the equipment used is different. Three types of laryngoscope blades are available. The curved blade is difficult to use in infants and small children because the larynx is relatively high and anterior in the neck of infants and small children. The straight blade and the modified curved blade (Miller type) with a curved tip are preferred. In general, the larger the blade, the better the visualization and tongue control. The No. 0 blade is useful in premature and term infants up to approximately 4 kg. The No. 1 blade can be used in most infants and young children. The No. 2 blade can be used in children older than 5 or 6 years.

Figure 6-1 Sizing an oral airway. With the phalange at the child's lips, the oral airway should just reach to the angle of the mandible, which is easily palpated just below the ear.

The Cole-type endotracheal tube with a tapered end, popular in the past for pediatric patients, should not be used because it increases vocal cord trauma and cannot be adequately suctioned to prevent mucus plugs. The use of cuffed tubes is not necessary in children under the age of 10. In these children the narrowest part of the airway is below the vocal cords. Therefore, a properly sized tube will fit comfortably through the cords, yet will fit snugly below the cords.

Several methods may be used to select the proper endotracheal tube size. The easiest is to choose a tube size equal to the diameter of the end of the child's little finger. Another method is to choose a tube the size of the child's nostril. Still another method is to use the following formula:

(16 + child's age in years) divided by 4

Whatever size tube is selected, tubes one size larger and one size smaller should be prepared so that they will be immediately available if needed.

Next, the laryngoscope is checked for functioning batteries and bulb. A large suction catheter is prepared. A stylet is fitted to the endotracheal tube so that its tip does not protrude beyond the end of the tube. Someone should be assigned the specific responsibility of monitoring the patient's heart rate. If at any time during the procedure the patient's heart rate deteriorates, the procedure should be aborted and the patient's lungs ventilated by bag and mask with 100 percent oxygen. The patient's head is placed in the

sniffing position previously described. The child is hyperventilated with bag, mask and 100 percent oxygen. The laryngoscope is placed in the left hand, and the blade is introduced a short distance into the right side of the patient's mouth. The tongue is swept to the left with the blade. The blade is then advanced gently until the tip is just under the epiglottis. Occasionally, the blade is most easily positioned under the epiglottis by first advancing the blade into the esophagus and then withdrawing it slowly until two cords suddenly appear and the epiglottis is resting on the blade. Gentle force is applied at an angle of 45 degrees up and away from the resuscitator until the vocal cords are revealed. The endotracheal tube is inserted into the right side of the mouth and guided through the cords under direct visualization. The endotracheal tube should be bent into a gentle curve. The curve should parallel the orientation of the blade when inserted into the mouth. Then, if necessary, the tube can be rotated slightly so that its tip points anteriorly to meet the cords. Figure 6-2 illustrates this part of the intubation technique, which is so important when a straight blade is used. The tip of the tube is passed only 1 to 2 cm beyond the cords in infants and 3 to 4 cm in children.
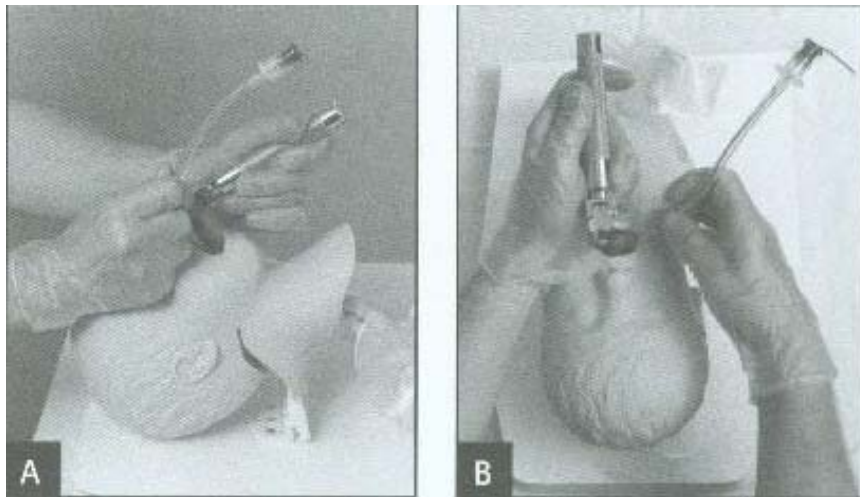

Figure 6-2 Intubation technique. A. Notice that (1) the endotracheal tube's curved shape, produced with the aid of a stylet, is the key to reaching the vocal cords, which extend above (anterior to) the tip of the laryngoscope blade; and (2) the endotracheal tube and laryngoscope handle form a 30-degree angle with each other. B. Rotating the tube toward the handle (reducing the angle) may further assist with proper placement. The tube is passed beside the laryngoscope blade, not down the blade aperture. This aperture is designed for continuous viewing of the vocal cords a function it cannot fulfill if the tube is passed through the aperture.

The single best sign that the tube is in position is improvement of the patient. Other signs include the presence of good chest movements and breath sounds that are clearly louder over the chest than over the stomach. Assessment of breath sounds over the chest alone is inadequate in the child because the child's airway is so close to her esophagus that it is easy to confuse her esophageal sounds with lung sounds. Breath sounds are also very helpful in determining if the endotracheal tube has been advanced too far into the trachea. If the breath sounds are louder on one side of the chest than the other, the tube is in the corresponding bronchus—a frequent error when intubating children. The tube should be slowly withdrawn until breath sounds are symmetrical. Perhaps the most important lesson regarding intubation of children, however, is summed up in the rule "if in doubt, take it out." Since most children can be easily ventilated with a bag and a mask, the EMT should not hesitate to remove a tube whose position is in doubt, reestablish bag-mask-valve ventilation and then reattempt intubation.

The most common complications of endotracheal intubation are hypoxia during the procedure, aspiration, esophageal intubation and right or left mainstem bronchus intubation. Because the large majority of children can be successfully ventilated with a bag and mask, excessive time should not be taken up by repeated attempts at intubation in the field. The key is getting oxygen into the lungs, not plastic into the trachea!

AIRWAY: SUSPECTED FOREIGN BODY

If the air-sniffing position and the jaw thrust-chin lift maneuvers do not provide an open airway, a foreign body must be suspected. The child's airway should be inspected. If readily apparent, the foreign body is removed with a finger sweep. (Blind sweeps are not recommended.) Next, the airway is suctioned, an oral airway is placed and positive-pressure ventilation is reattempted. If the airway is still not patent, then for children over one year of age abdominal thrusts should be performed with the rescuer positioned beside or straddling the child, who is lying supine on the floor. The rescuer must take care to place her hands in the midline (to avoid liver or spleen lacerations) just above the umbilicus. Five thrusts are delivered, their force modified according to the child's age. Then positive-pressure ventilation is reattempted with increasing pressure, if necessary. For infants, chest thrusts are used in place of abdominal thrusts. Hand position is the same as when delivering cardiac massage. The chest thrusts are delivered with greater force but at a slower rate than cardiac compressions. In infants less than one year of age, five back blows with the infant cradled head down on the rescuer's arm may also be attempted.

If the foreign body cannot be dislodged, it may be possible to ventilate around the foreign body with increased ventilatory pressures. This might, at first, appear to risk a pneumothorax. In fact, the resistance of the narrowed airway will dramatically reduce the pressure actually delivered to the lung. The bottom line is that the chest must rise. If it does not rise, greater pressure or additional airway clearing maneuvers must be used.

BREATHING

A bag-valve-mask apparatus permits ventilation with 100 percent oxygen. Masks come in various sizes. An adult mask can be used for an infant by inverting it so that the nasal part of the mask gets under the infant's chin. Clear masks have the advantage of allowing visualization of the patient's color and of the presence of vomitus. Many masks have an inflatable rim, which facilitates making a seal over the patient's mouth and nose.

Various sizes and types of resuscitation bags are available. Self-inflating bags are "fail safe" because they do not rely on a pressurized air or oxygen source. For newborns and small infants, 1/2 liter bags should be used. However, for most children, including adolescents, 1 liter bags are appropriate if an adequate mask-to-face seal can be maintained. Many resuscitation bags have pop-off valves to prevent the delivery of excess pressures to the child's lungs. These valves offer both advantages and disadvantages. For the child whose lungs are easily ventilated with low or moderate pressures, these valves definitely protect against pneumothorax. On the other hand, a child with an airway obstruction, such as a child with croup or an aspirated foreign body, may need very high pressures to allow air to pass beyond the obstruction. In this situation, the pop-off valve must be deactivated. The pressure drop across the obstruction will, in most but not all situations, protect the child from a pneumothorax.

Oxygen-powered breathing devices are not recommended for use on the pediatric patient because the high pressures generated can easily produce pneumothorax.

The rate of ventilation should be 20 per minute or one breath every 3 seconds for infants and children and 16-20 per minute in adolescents. It is particularly important that breaths be of sufficient volume to produce obvious chest rise. Finally, to minimize the risk of distending the stomach with air, inflation pressures should be as low as possible. Adequate chest expansion with low inflation pressure is achieved with a prolonged respiratory time. The new advanced cardiac life support (ACLS) protocols, which permit a pause in compression for ventilation, permit a longer inspiratory time than is possible under older ACLS guidelines.

CIRCULATION

Chest compressions must be done in the arrested child with no peripheral pulses. The easiest pulse to find in young children and infants is the brachial pulse. The precordial impulse is not a reliable guide to peripheral circulation and should not be used. Similarly, heart sounds do not guarantee adequate blood flow. The purpose of the heart is to pump blood, not to make noise or vibrate the chest. Therefore, the absence of pulses or a pulse less than 60 with signs of shock indicates the need for chest compressions.

Before initiating chest compressions, the patient should be placed on a hard surface so that the underlying surface does not absorb the force of the compressions. In infants and children compressions are performed over the lower third of the sternum. In infants this corresponds to an area one finger-width below a line drawn between the nipples. In older infants two finger widths are used; in small infants the resuscitator's hands may be wrapped around the infant's chest so that the fingers are under the infant's spine and the thumbs are on the lower third of the sternum. The chest is then compressed between the fingers and thumbs. Care must be taken to avoid squeezing the lateral rib cage which may produce multiple rib fractures. In older children, the heel of one hand is used.

The depth of compression is approximately ½ to 1 inch in infants, 1 to 1½ inches in children, and 1½ to 2 inches in adults. These distances correspond to approximately M of the anterior-posterior diameter of the chest. Adequacy of compressions is confirmed by palpating pulses. The rate of compressions is 100 per minute in infants, 80 to 100 per minute in children. However, because of a one second pause after each fifth compression to allow for a slow inspiration with adequate chest rise, the actual number of compressions for infants will be 80 per minute and for children 64 to 80 per minute. Table 6-3 summarizes information related to the performance of CPR in children.

During compressions the "down time" is equal to the "up time." That is, the compression is not a quick jab but a sustained push. When performing compressions, care must be taken to avoid pressure on the chest between compressions, preventing adequate refilling of the heart. In addition, the EMT must avoid removing the finger, thumb, or hand from the patient's chest between compressions so that proper hand position is maintained. The most common complication of chest compressions is one or more rib fractures, but this complication does not play a decisive role in patient survival.

At best, cardiac compressions produce cardiac output that is 30 percent to 40 percent of normal. Therefore, the technique of chest compressions must be meticulously followed. The key to providing effective compressions is to continually reassess their adequacy as judged by peripheral pulses.

TABLE 6-3 PEDIATRIC CPR STANDARDS

	Infant	Child (1-8)	Older child/Adolescent
PPV rate	20	15	12
Compression rate	> than 100	100 (minimum)	80-100
Compression hand	2 fingers or thumbs on mid-sternum (1 finger width below nipple line)	1 hand on lower half of sternum	2 hands on lower half of sternum
Compression depth	½ to 1 inch	1 to 1 ½ inch	1 ½ to 2 inches
Bradycardia (approximate-must relate to BP and perfusion)	100	60	60
Tachycardia (approximate-must relate to BP and perfusion)	180	140	120

Once chest rise is established via bag-to-endotracheal tube ventilation and palpable pulses have been established with properly performed chest compressions, the next step is to attach a cardiac monitor and determine the child's underlying rhythm. Gaining IV access, although important, is slightly less critical during the early resuscitation of the pediatric patient than it is for the resuscitation of the adult. This is fortunate because it is usually much more difficult to establish an IV line in an arrested pediatric patient than in an adult patient.

Two factors enable many arrested pediatric patients to be resuscitated before IV access is established. First, as already discussed, the majority of arrests in the pediatric population are primary respiratory arrests. If adequate ventilation is quickly established in these patients, spontaneous respiration and pulse often will return without the need for fluid or medication administration. Second, two of the three drugs that are most commonly required during a pediatric resuscitation, epinephrine and atropine, can be given via the endotracheal tube. (The inability to administer bicarbonate via the endotracheal tube can be compensated for by hyperventilating the patient's lungs.) One implication of this difference between pediatric and adult resuscitation is that starting an IV line on a pediatric patient experiencing cardiopulmonary arrest in the prehospital setting may not be the essential procedure that it is for an adult patient experiencing a cardiopulmonary arrest.

If starting an IV line is attempted, the antecubital and hand veins will be the easiest veins to cannulate. The actual technique is similar to that used on adult patients. However, the child's smaller veins and the smaller (and therefore sharper) catheters used make it difficult to thread up the vein rather than puncturing through the posterior wall of the vein. The EMT has two alternatives for gaining circulatory access if a catheter IV fails or appears too difficult to attempt. First a butterfly IV should be considered. Though much less stable than a catheter IV, a butterfly IV is much more easily placed because it is not threaded up the vein. The operator stops advancing as soon as a flashback occurs. Though unstable, a butterfly may permit a quick, early round of IV medications or a fluid bolus that would otherwise not have been possible.

Another alternative is intraosseous infusion (that is, an infusion into the bone marrow). The technique of intraosseous needle placement is simple, quick and safe. Its greatest application is for the rapid administration of fluid in the pediatric trauma victim. However, all resuscitative drugs may be effectively delivered through an intraosseous needle. Intraosseous infusion requires a heavy-gauge needle with a styler. The stylet is used to prevent plugging when advanced through the bone before entering the marrow space. The anterior tibia just below the knee is the site of insertion (see Chapter 4). Particularly in areas where transport times are long, EMTs should discuss with local medical directors the possibility of using the intraosseous technique.

In summary, gaining IV access via a catheter IV line on a pediatric patient experiencing cardiopulmonary arrest does not warrant prolonged attempts in the field. Either a butterfly or an intraosseous needle should be placed quickly or the endotracheal route should be used for the administration of drugs (see Chapter 7).

SUMMARY OF KEY POINTS

1. Most pediatric cardiopulmonary arrests are unwitnessed respiratory arrests followed by secondary cardiac arrest.
2. The success rate for pediatric cardiopulmonary resuscitation in the pre-hospital setting is, unfortunately, low. This low success rate results from the nature of pediatric cardiopulmonary arrest rather than inadequate pre-hospital care.
3. Prompt restoration of adequate ventilation, as judged by chest rise, is the most critical step in pediatric cardiopulmonary resuscitation.
4. Manual maneuvers will open the airway of the large majority of pediatric cardiopulmonary arrest victims, permitting effective initial ventilation via a bag and mask.
5. Positive-pressure ventilations are delivered with a slow inspiratory time and low pressures until chest rise is evident.
6. After every fifth compression, there is a pause to permit adequate chest rise with each ventilation.
7. The compression phase of each chest compression is equal to the relaxation phase.
8. IV access is not necessarily a critical step in pre-hospital pediatric cardiopulmonary resuscitation, because most of the resuscitation drugs used on children may be delivered via the endotracheal tube.

Chapter 7

Pediatric Dysrhythmias

OBJECTIVES

1. From a list identify the most frequently encountered dysrhythmias seen in pediatric patients and identify possible etiologies of those dysrhythmias.
2. Given a dysrhythmia and list of management strategies determine the appropriateness of each strategy.
3. Select the correct dose scheme for each of the drugs most likely to be used in the management of pediatric dysrhythmias.

Pediatric dysrhythmias are few and predictable compared to those seen in the adult population. This difference is related to the underlying condition of the pediatric heart compared to the adult heart prior to the occurrence of a cardiopulmonary arrest. The adult heart frequently suffers from a variety of different processes including prior infarcts, coronary artery disease and congestive heart failure. In addition, many adults who experience out-of-hospital cardiopulmonary arrest are on a variety of medications that may affect cardiac rhythm either by intent or by virtue of their side effects. As a result of these diverse factors, the adult heart gives rise to a complex set of dysrhythmias during a cardiopulmonary arrest.

In contrast, the pediatric heart is generally a healthy heart prior to an arrest situation. Consequently, as discussed in the previous chapter, pediatric dysrhythmias are usually secondary events resulting from hypoxia or shock. The healthy pediatric heart has a predictable response to hypoxia or shock. First, tachycardia occurs and lasts for a few minutes. Then bradycardia occurs if the hypoxia or shock is severe. Finally, asystole develops. If resuscitation is prompt and effective, generally a normal sinus rhythm will return. On the other hand, if resuscitation is delayed, either asystole will persist despite every effort to stimulate a rhythm or a regular rhythm will return but, because of the prolonged hypoxia to the heart muscle, the heart's pumping action will be ineffective, resulting in pulseless electrical activity (PEA). This sequence—tachycardia, bradycardia, asystole, PEA—is highly predictable. In fact, it is so predictable that it may be used to estimate the duration of the arrest prior to resuscitation and the potential for survival. For example, if bradycardia is present on arrival, it may be assumed that a period of tachycardia has already occurred and hypoxia has, therefore, been present for several minutes. If asystole is present, hypoxia can be assumed to have been of even longer duration.

ANTIDYSRHYTHMIC MEDICATIONS

The number of drugs needed to treat pediatric dysrhythmias is as limited as the number of arrest dysrhythmias that occur in the pediatric patient. There are only three "essential" drugs: oxygen, epinephrine and atropine. Lidocaine is rarely used. A final therapy that may be needed is Ringer's lactate or normal saline for fluid resuscitation. Each of these drugs will be reviewed with emphasis on

application to the pediatric patient.

EPINEPHRINE

Epinephrine in a dose of 0.1 ml/kg of 1:10,000 is useful for asystole and PEA. It may be repeated every 5 minutes for these dysrhythmias. The dose may be increased by a factor of 10 (0.1 mi/kg of 1:1000) if the standard dose fails to bring about the desired response. Some pediatricians also regard it as first line for bradycardia, particularly in the neonatal period, utilizing the lower dosage. It is important in the pediatric patient to utilize 1:10,000 dilution in order to deal with workable volumes of medication. With 1:1000 the dose becomes 0.01 mi/kg or, for example, 0.05 ml for a *5* kg infant, a difficult volume to measure and administer with accuracy. Epinephrine is also effective when given via the endotracheal tube. The optimal dose when administered by this route is uncertain. ACLS standards call for the dosage to be increased to 0.1 mg/kg of 1:1000 solution when epinephrine is given endotracheally. Local protocol and base station medical control should govern the dose used in a given situation. Epinephrine is most effective when acidosis has been at least partially corrected with hyperventilation.

ATROPINE

Atropine may be used for bradycardia following oxygenation and epinephrine administration. The dose of 0.02 mg/kg (0.2 ml/kg of 0.1 mg/ml, the concentration assumed for the remainder of this chapter) with a minimum dose of 0.10 mg (1.0 ml) and a maximum single dose of 0.5 mg (5ml) for the child and 1 mg (10 ml) for the adolescent. Atropine may be repeated after five minutes up to a maximum total dose of 1.0 mg for children and 2.0 mg for adolescents. The reason for the minimum dose is that very low doses have been shown to cause paradoxical slowing of the heart in infants. Atropine causes dilation of pupils. Therefore, it is desirable to check pupillary size and responsiveness prior to the administration of atropine. Atropine may also be administered via the endotracheal tube using two to three times the dose as would be used intravenously diluted to 3 to *5* milliliters in normal saline.

SODIUM BICARBONATE HYPERVENTILATION

There are two general approaches to the therapy of acidosis during a cardiopulmonary resuscitation: lowering C02 (hyperventilation) and raising bicarbonate (sodium bicarbonate administration). Recent research suggests that the first approach, hyperventilation, may be more effective than the latter in any arrested patient, pediatric or adult. The reason appears to be related to the speed with which these two therapies can affect intracellular acidosis, particularly acidosis within the cells of the heart muscle. Lowering CO_2 in the blood through hyperventilation almost immediately lowers C02 within cells, reducing intracellular acidosis. On the other hand, although bicarbonate promptly increased bicarbonate in the blood, it moves slowly into cells. Hence, bicarbonate's effect on the intracellular acidosis is delayed. In fact, because bicarbonate breaks down into C02 and water, the child's C02 may actually increase if adequate ventilation has not been established. This may, in turn, worsen intracellular acidosis.

During a pediatric cardiopulmonary resuscitation there are two additional reasons for preferring hyperventilation to bicarbonate administration. First, the arrest will frequently have been precipitated by respiratory failure. In this situation, CO_2 will be extremely high. Therefore, lowering CO_2 with

hyperventilation will be more effective than administering bicarbonate. Secondly, sodium bicarbonate can only be delivered via the IV route. IV access is often difficult during a pediatric arrest in the pre-hospital setting. When sodium bicarbonate is administered, the dose is 1 mEq/kg (1 ml/kg).

LIDOCAINE

As already discussed, ventricular fibrillation and ventricular tachycardia are rare dysrhythmias in children suffering out-of-hospital cardiopulmonary arrest. However, when they occur, for example in a child with congenital heart disease, Lidocaine is the drug of choice. The dose is 1 mg/kg by slow IV push. A continuous infusion in children is rarely needed.

Table 7-1 lists the doses of the drugs discussed above for standard pediatric patient weights and ages. Although the doses and calculations involve numbers that are easily remembered, a readily available table such as Table 7-1 is the safest and quickest method of ensuring accurate drug dosage in the acute situation on a pediatric patient.

TABLE 7-1 RESUSCITATION DRUG DOSES AND EQUIPMENT SIZES

Age	New-born	2 mos	5 mos	12 mos	3 ½ yr	6 yr	8 yr	9 ½ yr	11 yr	12 yr	13 yr	14 yr
Weight – lb	7.5	11	15	22	35	45	55	65	80	90	100	110
Weight – kg	3.5	5	7	10	15	20	25	30	35	40	45	50
ET	3	3.5	4	4 – 4.5	5	5.5	6	6.5	6.5	7	7	7.5
Suction cath for ET (Fr.)	5/6	8	10	10	14	14	14	14	14	14	14	14
NG (Fr.)	10	10	10	10	12	14	14	14	16	16	16	16
Fluid push (RL or NS)	70 ml	100 ml	140 ml	300 ml	400 ml	400 ml	500 ml	600 ml	700 ml	800 ml	900 ml	1000ml
Defib: start at 2 ws/kg	7 ws	10 ws	15 ws	20 ws	30 ws	40 ws	50 ws	60 ws	70 ws	80 ws	90 ws	100 ws
Atropine 0.02 mg/kg IV (.1 mg/ml)	0.1 mg 1 ml	0.1 mg 1 ml	0.14 mg 1.4 ml	0.2 mg 2 ml	0.3 mg 3 ml	0.4 mg 4 ml	0.5 mg 5 ml	0.5 mg 5 ml	0.5 mg 5 ml	0.5 mg 5 ml	1.0 mg 10 ml	1.0 mg 10 ml
Bicarbonate 1 Meq/kg	3.5 Meq	5 Meq	7 Meq	10 Meq	15 Meq	20 Meq	25 Meq	30 Meq	35 Meq	40 Meq	45 Meq	50 Meq
Epinephrine 1:10,000 0.1 mg/kg IV (0.01 mg/kg)	0.5 ml	0.5 ml	0.7 ml	1 ml	1.5 ml	2 ml	2.5 ml	3 ml	3.5 ml	4 ml	4.5 ml	5 ml
Glucose 0.5 g/kg D50W = 0.5 g per ml	3 ml	5 ml	7 ml	10 ml	15 ml	20 ml	25 ml	30 ml	35 ml	40 ml	45 ml	50 ml
Naloxone 0.4 mg/ml 0.02 mg/kg	0.15 ml	0.25 ml	0.35 ml	0.5 ml	0.75 ml	1 ml	1.25 ml	1.5 ml	1.75 ml	2 ml	2.25 ml	2.5 ml
Diazepam 0.2 mg/kg	0.7 mg	1 mg	1.5 mg	2 mg	3 mg	4 mg	5 mg	5 mg	5 mg	5 mg	5 mg	5 mg

PEDIATRIC ARREST DYSRHYTHMIAS

ASYSTOLE

Unfortunately, asystole is the most common arrest dysrhythmia that EMTs must deal with in the pre-hospital setting. The following are the basic steps involved in the pre-hospital treatment of pediatric asystole:

1.   BCLS
2.   Intubate
3.   Epinephrine 0.1 ml/kg 1:1000 ET (0.Olml/kg if IV/IO access is easily attainable)
4.   Load-and-go
5.   Correct underlying causes

After establishing effective basic cardiopulmonary resuscitation (CPR) with visible chest rise with each ventilation and palpable pulses with each compression, the child should be intubated both to protect the airway and to provide a route for drug administration. Epinephrine (0.1 ml/kg 1:10,000) is then administered via an established vascular route or recommended endotracheal doses (0.1 ml/kg of 1:1000) may be administered via the endotracheal tube. If IV access appears easily attainable, it should be attempted no more than twice. Regardless of success or failure at establishing venous access, load-and-go is the next step. Additional doses of epinephrine might be considered as might administration of sodium bicarbonate during long transports after consulting base station medical control. Unlike treatment of adult patients with asystole, defibrillation for suspected fine ventricular fibrillation masquerading as asystole is not indicated in the pediatric patient. This maneuver would needlessly interrupt basic CPR.

BRADYCARDIA

Bradycardia prior to any drug therapy should be regarded differently than bradycardia that occurs after drug therapy for asystole. Initial bradycardia is almost always secondary to hypoxia. The following are the basic steps involved in the pre-hospital treatment of pediatric bradycardia:
1.   BCLS for pulse less than 60 and signs of shock.
2.   Ensure effective ventilation with 100 percent oxygen.
3.   Intubate if pulse remains less than 60.
4.   Epinephrine 0.1 ml/kg of 1:1000 El or 1:10,000 IV.
5.   Atropine 0.4 ml/kg of 0.1 mg/ml El (minimum 2 ml) (.2 mI/kg IV; minimum 1 ml).
6.   Load-and-go.

Improved ventilation is the preferred therapy. In fact, without improved ventilation, atropine will probably be ineffective. Bradycardia following asystole, on the other hand, may represent a primary cardiac dysrhythmia for which atropine might be effective. If IV access has been achieved, a bolus of 1 ml/kg of bicarbonate might also be tried. Finally, the definition of bradycardia in infants and children is different than for adolescents and adults. In infants less than one year of age who are in distress, a rate less than 100 should be regarded as bradycardia. For children in distress, a rate less than 60 defines bradycardia. There are two reasons for choosing these relatively high numbers to define bradycardia in

infants and children. First, the normal heart rates in infants and children are faster than in adults. Secondly, the adult's heart is able to compensate for a slow rate with increased stroke volume (amount of blood pumped with each heartbeat). The pediatric heart does not do this nearly as well. Consequently, the highly conditioned adult may maintain a normal cardiac output per minute with a heart rate as low as 40. However, a heart rate of 60 in an infant or child is unacceptable. Hence, compressions should be continued in an infant or child until the heart rate is above 60 and pulses are palpable. Furthermore, drug therapy should be administered until the heart rate is above 80 for children and above 100 for infants less than one year of age. In summary, for bradycardia not responsive to improved ventilation, epinephrine (0.01 mg/kg) or atropine (0.2 ml/kg) is used either intravenously or recommended higher doses endotracheally. In newborns particularly, epinephrine is preferred (see Chapter 11).

PULSELESS ELECTRICAL ACTIVITY

The following are the basic steps involved in the pre-hospital treatment of pediatric pulseless electrical activity (PEA):

1.   BCLS.
2.   Intubate.
3.   (Trauma only) rule out or treat pneumothorax.
4.   IV access if quickly established (if not load-and-go and proceed to step 7).
5.   Load-and-go.
6.   Ringer's lactate (20 ml/kg) over 5 to 10 minutes en route.
7.   If PEA persists, epinephrine (0.1 ml/kg of 1:10,000 IV or 1:1000 Et). (If volume loss is certain, substitute a second bolus of Ringer's lactate for the epinephrine.)

PEA most frequently occurs following therapy for asystole. In this situation the most likely cause is a heart muscle that has been deprived of oxygen for a prolonged period of time. It may also be the first rhythm diagnosed in a child who is suffering from severe volume loss or a severe infection. A third possible cause to be considered when dealing with a trauma victim is a tension pneumothorax that prevents the heart from adequately filling. If there are no palpable pulses, basic CPR should be continued or initiated regardless of the rhythm appearing on the monitor. Next, pneumothorax in the trauma victim should be quickly ruled out or, if diagnosed, treated with needle decompression. The final step is a bolus (over 5 to 10 minutes) of 20 ml/kg of normal saline or Ringer's lactate as described in Chapter 4. Finally, if PEA follows resuscitation of an asystolic heart and if fluid loss, infection and pneumothorax seem unlikely, epinephrine and bicarbonate should be administered. Epinephrine not only may increase the strength of heart contraction, producing palpable pulses, but also may increase heart rate as another means of increasing total cardiac output per minute.

NARROW COMPLEX TACHYCARDI A

An algorithm outlining the basic steps in the pre-hospital treatment of pediatric narrow-complex tachycardia is presented in the box on p. 76. Narrow-complex tachycardia with a definite history of volume loss is treated with a bolus of 20 mI/kg of normal saline or Ringer's lactate (as discussed in

Chapter 4). The approach to narrow-complex tachycardia without a definite history of volume loss varies with the presence or absence of pulses. If pulses are present, no therapy other than rapid transport is indicated. This situation may represent either occult volume loss, sepsis or supraventricular tachycardia (SVT). SVT is the most common spontaneous rhythm disturbance in pediatric patients. Differentiating between SVT and volume depletion (or sepsis) is difficult. The therapies for the two conditions differ drastically. If pulses are present, the best approach is rapid transport to an emergency department. Tachycardia with absent pulses should be treated as PEA. In particular, cardiac compressions are indicated. If SVT is the cause of tachycardia, the mechanical compressions alone may convert the child's heart to a normal sinus rhythm. If this does not occur, then medical control should be consulted regarding a fluid bolus, as called for in the management of PEA, or the use of cardioversion with 0.4 to 0.8 joules/kg. Because most of these patients will be infants and small children, electrical cardioversion will only be possible if the defibrillator available is capable of timed cardioversion and capable of delivering current in the range of *5* to 10 watt-seconds and has pediatric paddles.

VENTRICULAR FIBRILLATION AND
WIDE COMPLEX TACHYCARDIA WITHOUT PULSES

The following are the basic steps involved in the pre-hospital treatment of pediatric ventricular fibrillation and wide-complex tachycardia without pulses:
1. No precordial thump in children.
2. Defibrillate 2 watt-sec/kg (if effective, go to steps 5, 6, 8 and 10). (Synchronize for wide-complex tachycardia with pulse.)
3. Defibrillate 4 watt-sec/kg (if effective go to steps 5, 6, 8 and 10).
4. Defibrillate 4 watt-sec/kg.
5. BCLS.
6. Intubate (and establish IV access if quickly attainable).
7. Epinephrine 0.1 mI/kg 1:10,000 IV (1:1000 ET).
8. Lidocaine 1 mg/kg ET or IV.
9. Defibrillate 4 watt-sec/kg.
10. Load-and-go.

Ventricular fibrillation is a rare occurrence in the pediatric age group. When it does occur, the paddle position for small infants is anterior/posterior. In older children the paddle position is the same as the adult. Lidocaine (1 mg/kg) should be given after defibrillating unless the subsequent rhythm is idioventricular, which is a very rare occurrence in the pediatric age group. Lidocaine may be administered via the endotracheal tube in the same dose as is used intravenously.

SUMMARY OF KEY POINTS

1. Pediatric dysrhythmias are secondary events which are infrequent and predictable.
2. The most frequently encountered dysrhythmias are asystole, bradycardia, PEA and tachycardia.
3. Epinephrine and atropine are the mainstays of pediatric dysrhythmia therapy in the field.
4. Acidosis occurring during a pediatric arrest may be treated by hyperventilation as effectively, if not more effectively, than the administration of sodium bicarbonate.
5. Because epinephrine, atropine and Lidocaine may be administered via the endotracheal tube and because hyperventilation may also be accomplished via an endotracheal tube, IV access is not necessarily a top priority when dealing with a pediatric patient experiencing cardiopulmonary arrest in the field.
6. The primary indication for use of an IV line on a pediatric patient experiencing cardiopulmonary arrest in the field is PEA, for which a fluid bolus is indicated.
7. The pediatric resuscitation doses of epinephrine, bicarbonate and Lidocaine are easily remembered: epinephrine 0.1 ml/kg of 1:10,000; bicarbonate 1 Meq/kg; Lidocaine 1 mg/kg.
8. The pediatric resuscitation dose of atropine and volume of a fluid bolus given during a resuscitation are easily remembered:
    atropine 0.2 mi/kg; normal saline 20 ml/kg.
9. Though the doses of pediatric resuscitative drugs are easily remembered, the best method of avoiding errors is use of a chart containing pre-calculated drug doses for pediatric patients of all ages and weights.

Chapter 8

Pediatric Trauma

OBJECTIVES

1. Given a list of traumatic injuries, tell whether each is more or less frequent in children than in adults.
2. Identify the appropriate management of a given traumatic injury.
3. Identify from a list assessment parameters most indicative of increased intracranial pressure and the most appropriate therapy for this condition.
4. Determine whether statements regarding assessment of the fontanel are true or false.

PEDIATRIC TRAUMA

Trauma kills more children and accounts for more pediatric EMS runs than all other causes combined. It is extremely important that EMTs are well trained and knowledgeable in the management of pediatric trauma.

There are many differences between pediatric and adult trauma. Over 90 percent of life-threatening pediatric trauma is blunt trauma, from causes such as motor vehicle accidents and falls. Less than 10 percent is penetrating trauma, from causes such as gunshot wounds, stabbings and power tool accidents. In contrast, life-threatening adult trauma is almost 50 percent penetrating trauma. Although there are many exceptions, penetrating trauma is more likely to result in rapid deterioration and more likely to require surgery within the first 'golden' hour.

Head trauma plays a relatively greater role in pediatric trauma mortality than in adult trauma mortality. Over 60 percent of pediatric major trauma patients have a significant head injury. More than 80 percent of those who succumb to their injuries have significant head injuries. In contrast, infants and children are more likely to successfully recover from severe head injury than adults. In a recent study, greater than 50 percent of pediatric patients comatose for more than 24 hours after a head injury made a good recovery.

Pediatric trauma occurs predominantly in the late afternoon and early evening. Only *5* percent of pediatric trauma patients are transported by the EMS system between the hours of midnight and 8:00 A.M. Experienced EMTs know that this contrasts sharply with the time-of-day distribution of adult trauma, particularly penetrating trauma.

GENERAL APPROACH

Despite the many epidemiological differences between pediatric and adult trauma, the general approach to the assessment and management of both groups of trauma patients is exactly the same both in the field

and in the emergency room:

1. Cervical spine stabilization.
2. Airway assessment and management.
3. Breathing assessment and management.
4. Circulatory assessment and management.
5. Disability-neurological assessment and management.
6. Rapid head-to-toe examination.

Within each category, there are many differences between pediatric and adult multiple trauma patients. The following pages will highlight the differences that are most critical to pre-hospital management.

CERVICAL SPINE STABILIZATION

A cervical spine injury in a pediatric patient is unusual. Only 3 percent of all cervical spine fractures occur in patients less than 15 years of age. Nevertheless, cervical spine injury must always be suspected when dealing with a pediatric trauma patient. When a cervical spine injury is present in an infant or young child, the location of the injury is commonly the upper cervical spine. This has important implications for immobilization. Semi-rigid cervical collars, such as the Philadelphia collar, immobilize the lower cervical spine more effectively than the upper cervical spine. For this reason and because the proper size cervical collar for a given child is often not available, the use of towel rolls and tape or foam blocks and velcro straps are more satisfactory means of immobilizing the cervical spine of an infant or young child. Often, this immobilization is, best carried out in the infant's own car seat.

Another problem the EMT faces is how to transfer an alert, frightened toddler to a spine board for immobilization without causing further damage to the cervical spine during the ensuing struggle. This is no small challenge. In fact, there are case reports of the onset of neurological deficits during attempts to immobilize a struggling child. A sufficient number of personnel should be present before performing the maneuver. Each person should know her role and be capable of using sufficient restraining force to carry out her role. If an EMT team determines that there is risk in transferring a child from a parent's lap or arms to the spine board, then base station medical control should be contacted for orders to transfer the child in the parent's arms rather than on the board. Obviously, this entails some risk. On the other hand, forceful restraint of a struggling toddler is also risky. With the help of base station medical control, a judgment can be made regarding the lesser of the two risks.

Another difference between pediatric and adult cervical spine injuries is that pediatric cervical spine injuries are frequently present in the absence of positive findings on a lateral neck x-ray. This has implications for EMTs performing inter-hospital transfers of pediatric trauma victims. In particular, a normal lateral cervical spine x-ray, in itself, should not be used to clear the cervical spine in an infant or an unconscious or uncooperative toddler. Immobilization should be maintained pending more definitive x-ray examinations or orthopedic or neurosurgical consultation. If the transferring hospital has, discontinued immobilization on the basis of a normal lateral cervical spine x-ray, then the EMTs performing the transfer should consider re-establishing immobilization of the cervical spine during

transfer.

Finally, recent data have demonstrated that the stabilization of a small child's neck on a long spine board actually results in some degree of flexion of the cervical spine. This occurs because of the child's large occiput (back of the head). A folded blanket placed on the spine board to support the child's shoulders, so that the child's ear is aligned with his shoulder, will prevent this inadvertent neck flexion.

AIRWAY ASSESSMENT AND MANAGEMENT

The most important single maneuver an EMT can perform on the multiple-injured child is to open the airway. Because the child's airway is small, it is easily occluded by mucus, blood, debris or the child's own tongue. The airway is opened as described in Chapter 5. A chin-lift or jaw-thrust maneuver is performed without disturbing in-line cervical spine stabilization. The airway is suctioned if upper airway rhonchi are heard. Readily apparent foreign substances are manually removed. An oral airway is used only if necessary. Patency of the airway is determined by breath sounds during spontaneous respirations or by chest rise with positive-pressure ventilations. If there is difficulty in obtaining an open airway or if the child is unconscious, intubation is indicated. Although maintaining in-line stabilization makes intubation of the adult difficult, it is not as much of a hindrance when intubating the pediatric trauma victim. In fact, the neutral position is generally the optimal position for intubating an infant or child. Blind nasotracheal intubation is considerably more difficult in the pediatric patient than in the adult patient, particularly when in-line immobilization must be maintained. This maneuver is not recommended on pediatric trauma victims.

Needle cricothyroidotomy is also discouraged on infants and small children. The small trachea with its less well-defined landmarks makes needle cricothyroidotomy a difficult procedure on these patients. Adequate airways can almost always be established by other means. In the rare case of a child with severe facial trauma in which a patent oral airway cannot be obtained, needle cricothyroidotomy should be considered as a "last-ditch" method of establishing an airway.

BREATHING ASSESSMENT AND MANAGEMENT

At a minimum, all severely injured infants and children should have their breathing supported with high-concentration oxygen. If there is apnea, gasping or cyanosis despite oxygen therapy, high-concentration oxygen should be delivered with positive-pressure ventilation. Pediatric patients are less vulnerable to many of the chest injuries adult trauma patients experience. Rib fractures, for example, are uncommon because the pediatric rib cage is softer and more resilient. It bends, resulting in lung contusion, but does not break easily. Therefore, flail chest is also uncommon in pediatric trauma patients.

Pneumothorax does occur frequently. The signs of pneumothorax are the same as in the adult trauma victim: asymmetrical chest rise, asymmetrical breath sounds, and a shift in the heart away from the affected side when the pneumothorax is under tension. (Tracheal deviation may also be seen in the adolescent, but it is difficult to appreciate in infants and children.) Most pneumothoracies in pediatric patients do not require treatment in the field. In fact, many pneumothoracies in pediatric patients do not

require decompression after arrival in the emergency room. However, if the child's color or pulse oximetry is unacceptable despite positive-pressure ventilation and there are signs of a tension pneumothorax, then needle decompression in the field must be carried out in the same fashion that it is performed on the adult patient. The same size catheter is used (14 or 16 gauge) and is placed in the second intercostal space, midclavicular line of the affected side. The catheter should be left in place and open to air during positive-pressure ventilation. Finally, open chest wounds are uncommon in pediatric victims because of the low frequency of penetrating trauma to children. These wounds are treated in children as in adults with a petrolatum gauze dressing or other occlusive dressing.

The end point of airway and breathing management in a pediatric trauma patient is a non-cyanotic skin color (or acceptable pulse oximetry, if available). As discussed in Chapter 3, this does not guarantee normal oxygenation. However, a non-cyanotic skin color probably indicates sufficient oxygenation to permit safe transport. This goal of a non-cyanotic skin color will nearly always be achieved if clearly visible chest rise is obtained while a child is breathing high-concentration oxygen spontaneously or with positive-pressure ventilation. If this end point is not achieved with these maneuvers, then an EMT should look for a pneumothorax and treat it just as it is treated in the adult patient.

CIRCULATORY ASSESSMENT AND MANAGEMENT

As discussed in Chapter 4, circulation in the pediatric patient at the scene of an accident is best assessed using signs of peripheral circulatory compromise. Delayed capillary refill, weak peripheral pulses, and cool, pale extremities provide strong evidence that there has been substantial blood loss. Blood pressure may be normal despite these signs of peripheral circulatory insufficiency because of the pediatric patient's tremendous ability to vasoconstrict blood vessels in response to blood loss. The presence of these peripheral signs of shock warrants an attempt to gain IV access regardless of the child's blood pressure.

The indications for delivering a fluid bolus to an injured child in the field setting are less well defined than for the adult, precisely because blood pressure is less useful as a guide to the degree of blood loss in a child. Furthermore, because head injury and increased intracranial pressure play such a major role in pediatric trauma mortality, the indiscriminate use of fluid boluses on pediatric trauma victims could complicate the care of some of these patients. There are three situations, however, in which a 20 ml/kg bolus of saline or Ringer's lactate would be clearly indicated:

1. Systolic blood pressure less than 80 (CAUTION: Proper cuff size must be used).
2. Systolic blood pressure over 80 but obvious blood loss (tense, swollen thigh, puddled blood from scalp injury, etc.).
3. Systolic blood pressure between 80 and 100 (or not available) and marked alteration in signs of peripheral circulation.

Note that if the systolic blood pressure is greater than 100 and significant blood loss is not obvious, a fluid bolus is not indicated despite peripheral circulatory signs that might suggest some volume loss. In this setting, the altered peripheral signs may reflect central nervous system dysfunction rather than blood loss. Fluid administration could aggravate this situation. Medical control should be contacted for

guidance.

Three final points in the field management of pediatric circulatory failure resulting from trauma must be made. First, obvious shock in a pediatric patient is a load-and-go situation. After cervical spine immobilization, airway control, and at most, one attempt at IV access, it is time to move the patient. Second, one fluid bolus may not be sufficient. If the first bolus is completed en route but the child remains in shock, then a second bolus should be started immediately. Third, any active bleeding must be effectively tamponaded. An arterial bleeder buried in a scalp laceration can bleed just as much in a small child as it can in an adult. However, because the pediatric patient's total blood volume is so much smaller than that of the adult, the blood loss from such an external bleeding site poses a much greater threat to the child than to the adult. Effective tamponading of external bleeding requires manual pressure. A pressure dressing is inadequate and will have no effect on arterial bleeding and minimal effect on venous bleeding.

DISABILITY:
NEUROLOGICAL ASSESSMENT AND MANAGEMENT

At the scene the neurological assessment of a pediatric patient is limited to assessment of mental status, pupils, and in the infant, the fontanel. Mental status is crudely graded based on the following criteria (identified by the mnemonic AVPU): Alert, responsive to verbal stimuli, responsive to painful stimuli and unresponsive. The EMT should also note the nature of the child's responses to verbal and painful stimuli. In particular, are the responses appropriate and purposeful or non-purposeful or do the muscle movements appear to be posturing movements suggesting central nervous system injury? Posturing takes two forms, decerebrate and decorticate, as illustrated in Figure 8-1. Pupils are checked for equality and reactivity. The fontanel is checked for firmness.
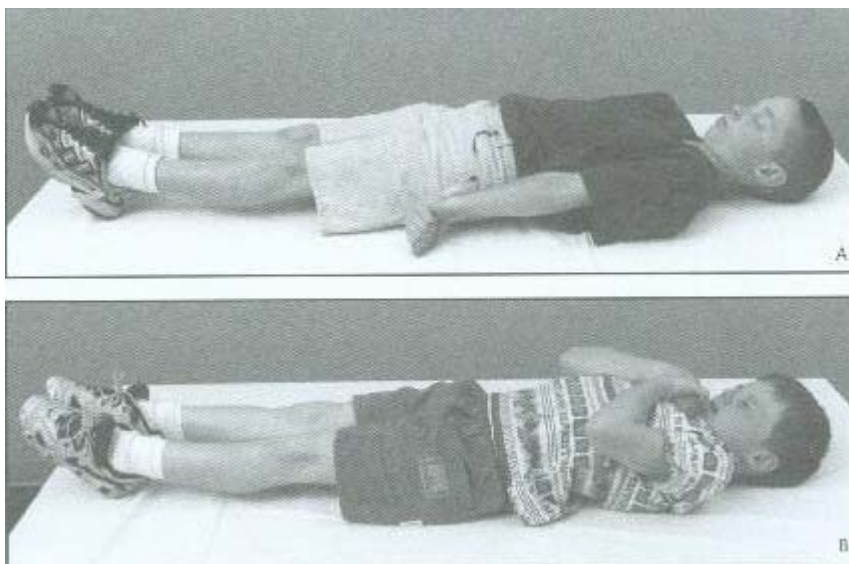

Figure 8-1 Decerebrate/decorticate posturing. A. In decerebrate posturing all extremities are extended and rotated inward. B. In decorticate posturing the legs are extended and the arms are flexed. Progression from decorticate to decerebrate is an ominous sign.

Increased intracranial pressure is one of the most feared consequences of pediatric trauma. Fortunately for the field management of pediatric trauma, increased intracranial pressure is usually, but not always, a

delayed reaction to severe head injury. Signs of increased intracranial pressure include posturing or unresponsiveness, unequal pupils, a firm fontanel and the combination of hypertension and bradycardia. The combination of increased intracranial pressure and shock is particularly devastating. In effect, blood supply to the brain is cut off when this situation occurs because blood under low pressure cannot force its way into the cranial vault due to the high pressure opposing its flow. When this combination of shock and suspected increased intracranial pressure occurs, it is important to aggressively treat the child's shock with fluid boluses, despite the fact that the fluid boluses may aggravate increased intracranial pressure. This exacerbation of increased intracranial pressure is, in turn, treated with hyperventilation, as discussed below. In contrast, if increased intracranial pressure is present without shock, then fluid restriction is essential. If an IV line is started, its rate should be set at a keep-vein-open (KVO) rate. Another simple maneuver in this situation is to elevate the head of the stretcher by 30 degrees to increase venous drainage from the brain, thereby lowering intracranial pressure.

There are two principal means of lowering increased intracranial pressure: hyperventilation and administration of Mannitol. Hyperventilation is extremely effective. It lowers intracranial pressure within seconds. Mannitol acts more slowly. In fact, because it is a fluid bolus, Mannitol initially increases intracranial pressure before its osmotic effect acts to lower it. Therefore, in the field setting, Mannitol is rarely used. When hyperventilation is established, it will generally be adequate to control increased intracranial pressure in the field.

Anti-inflammatory steroids (for example, dexamethasone) have not been shown to favorably affect increased intracranial pressure caused by trauma. Because there is some evidence that these drugs may actually worsen the prognosis for patients with head injuries, they are no longer used. It is inappropriate for an EMT to start an IV line in the field solely for the purpose of administering IV steroids to a trauma patient.

The treatment of suspected, increased intracranial pressure varies with the presence or absence of shock. If shock is present, the child is treated with fluid boluses and hyperventilation. If shock is absent, the child is treated with hyperventilation, fluid restriction and elevation of the head of the spine board.

RAPID HEAD-TO-TOE
ASSESSMENT AND PHYSICAL EXAM

If a life-threatening injury has been identified during the assessment and stabilization of the ABCDs, the next step is "load-and-go." Exposing the child and performing a detailed head-to-toe evaluation will not change management during transport nor will it affect the choice of receiving institution. It is important, however, to do a quick inspection for active hemorrhage and to determine if manual stabilization of gross fractures is necessary when moving the patient to the spineboad. To thoroughly assess and manage injuries, such as orthopedic injuries, would distract attention away from the child's most critical needs and delay transport.

If the child's ABCDs are stable, it is important to expose him and examine for signs of injury beyond those described above. The findings may help the EMT to anticipate deterioration in the ABCDs and also

to determine the most appropriate receiving institution for the child. For example, if blood in the ear is noted, the EMT is alerted to the increased possibility of neurological deterioration. The finding would also indicate the need to transport the child to a trauma center, or more specifically, to a pediatric trauma center that has pediatric computed tomography scanning and pediatric neurosurgical capabilities. Calling ahead with the information gained from the head-to-toe examination will also assist the receiving institution in mobilizing the proper resources for the care of the child.

There are two potential risks of exposing a pediatric trauma victim and performing a thorough head-to-toe evaluation. First, transport is delayed. To minimize this risk, the head-to-toe examination should be conducted quickly, preferably in less than 60 seconds. Second, exposing the pediatric patient incurs the risk of hypothermia, which is a decrease in body temperature. For this reason as well, the head-to-toe examination should be done quickly. If air temperature is low, this examination should be deferred until the child is loaded into a warmed transport vehicle.

Table 8-1 lists the most critical observations to be made during a head-to-toe evaluation of a pediatric trauma patient and the potential relevance of each observation to the EMT.

TABLE 8-1 FINDINGS AND RESPONSES IN PEDIATRIC TRAUMA

Finding	Response
Head	
Blood from the ear	Choice of institution
Eye damage	Soft patch
Damaged teeth	Removal to avoid aspiration
Mouth bleeding	Prepare suction
Penetrating scalp injury	Choice of institution
Scalp hematoma	Anticipate shock in a small infant
Abdomen	
Distention	Choice of institution; anticipate difficulty ventilating secondary to a distended stomach; anticipate vomiting, prepare suction, anticipate possible shock secondary to intra-abdominal bleeding
Bruising, tenderness	Choice of institution; anticipate shock
Pelvis	
Bruising, tenderness	Choice of institution; anticipate shock
Extremities	
Deformity, unequal pulses	Splinting
Skin	
Multiple old bruises	Suspect child abuse

HEAD

As has already been noted several times, pediatric trauma includes head trauma until proven otherwise. Head trauma causes or contributes to 80 percent of pediatric trauma mortality. Why does the pediatric trauma victim so frequently suffer a major head injury? One reason is that the head makes up a large proportion of the child's total body mass—over *25* percent in early infancy. Another reason is that the child's relatively weak neck and upper extremity muscles make it more difficult for the child to protect his head from injury. A final reason is that the infant's skull is very soft. It easily deforms under the pressure

of a blow, resulting in brain injury. One beneficial aspect of the infant's soft skull is that it can expand somewhat by widening its suture lines—those points where the various bones that make up the skull come together. This helps to dampen the effect on intracranial pressure produced by some injuries.

The care of pediatric head trauma is very complex. The sooner electronic monitoring of intracranial pressure in an intensive care unit experienced in the care of pediatric head trauma can be established, the better! Early recognition of a possible head injury will enable the EMT to choose the proper receiving institution for the injured child. Also, the EMT's radio report will enable the receiving institution to mobilize the appropriate resources for the care of the injured child. Finally, if the EMT identifies a head injury, she should increase the frequency with which pupillary size, mental status, muscle tone, pulse and blood pressure are monitored during transport. If the child is not in shock, the head of the spine board should be elevated to 30 degrees.

ABDOMEN

Abdominal injury is the second leading cause of traumatic death in the pediatric age group, principally because of lacerations of the liver and spleen. These organs are especially vulnerable in the pediatric patient for three reasons. First, the abdominal wall is thin, so the organs are closer to the surface of the abdomen. Second, the abdominal wall is less muscular in a child than in an adult. Consequently, the abdominal wall is less able to block a blow to the abdomen from penetrating deeply into the abdominal cavity. Third, the liver and spleen of a small child are lower in the abdomen and less protected by the rib cage. Bruising or abdominal distention should lead the EMT to suspect shock or impending shock from a lacerated liver or spleen. Shock may develop gradually or suddenly in the pediatric trauma patient. Such injuries obviously require transfer to a trauma center. Interestingly, almost 80 percent of lacerated spleens in the pediatric age group are now managed non-operatively. The child is admitted to an intensive care unit, transfused and closely monitored. If blood pressure and other signs of circulatory status stabilize, no operation is performed. The spleen repairs itself. Discharge is often possible within a few days.

Abdominal distention should lead the EMT to suspect a stomach distended with air. Exactly why this so frequently complicates pediatric multiple trauma is unknown. However, it is known that it can lead to marked compromise in either the child's spontaneous ventilations or in positive-pressure ventilation. Pressure on the stomach is not a viable option because it may result in vomiting and aspiration. If bag-mask-valve ventilation is thought to be ineffective secondary to a distended stomach, the next step is intubation. If vomiting occurs, the EMT must prepare to suction the oropharynx and rapidly turn the spine board. If intubation is chosen, higher pressures than might normally be used may be needed to generate chest rise.

EXTREMITIES

Suspected forearm fractures should be splinted in the position in which they are found. If the child is alert, suspected elbow and upper-arm fractures are best managed in the field with a sling. If the child's mental status is depressed, suspected elbow and upper-arm fractures are best managed by wrapping the injured limb against the body in the position in which it is found. Lower-extremity fractures should be splinted on a board splint if pulses are intact and there is no obvious angulation. Otherwise, a traction splint should be

applied. Any break in the skin at or near the site of a fracture of an upper or lower extremity should be carefully dressed before splinting.

The hospital management of a pediatric fracture is complicated by the ongoing growth of the pediatric skeleton. Improper treatment may lead to permanent angulation or limb shortening as skeletal growth continues. These injuries require transport to a facility prepared to provide the specialized care needed to obtain optimal results.

MECHANISM OF INJURY

In addition to a thorough examination of the child, ascertaining the exact mechanism of injury may help both the EMT and physician to identify subtle injuries more quickly. For example, the EMT should suspect cervical spine injury in the infant who was strapped in a car seat, facing forward and moving at a high velocity prior to a head-on collision.

In this setting, the infant's large head moves forward, literally stretching the neck against the resistance of the infant seat's shoulder restraints (figure 8-2). The result is injury to the spinal cord without obvious cervical-spine injury on X-ray examination. The same injury can occur with the child riding backward if the seat has been rotated into a reclining position (a feature of many car seats). If the seat is facing backward, in the upright position and with proper restraints, neck injury will be much less likely. If time and the child's condition permit, it is one of the crucial duties of the EMT to precisely define the mechanism of injury in order to further anticipate potential injuries.

Figure 8-2 Torsion neck injury. The infant's head (large and unrestrained) applies a tractional force to the neck in a head-on collision. The infant's weak neck musculature and weak cervical ligaments cannot resist this tractional force effectively. The result is elongation of the spinal cord and shearing damage to the nerves in the spinal cord.

SUMMARY OF KEY POINTS

1. The general approach to the pediatric trauma patient is the same as for the adult trauma patient: cervical spine control, ABC, head-to-toe examination.
2. Cervical spine fractures are uncommon in children. The cervical spine of a pediatric patient is best immobilized with towel rolls and tape or foam blocks and velcro straps. The cervical spine of the awake, frightened toddler should be immobilized with great care to avoid further damage resulting from the child's resistance to the procedure.
3. The most important single maneuver EMTs perform on most pediatric multiple trauma patients is opening the airway. The airway of the pediatric patient is smaller, hence it is more easily occluded. The neutral position (with gentle in-line cervical stabilization), a chin lift or jaw thrust and suction or manual clearing will open the airway of most pediatric trauma patients. The neutral position will permit most pediatric trauma patients to be intubated. Extension of the neck is not needed.
4. All pediatric trauma patients should receive high-concentration oxygen, if tolerated. If positive-pressure ventilation is needed for apnea, gasping, or cyanosis with oxygen, the key is to move the chest. A distended stomach (with air) or a pneumothorax may make moving the chest difficult. Pneumothorax is the most common serious chest injury in the pediatric trauma patient. Rib fractures, flail chest and open chest wounds are very uncommon.
5. A tension pneumothorax in a pediatric trauma patient is relieved in exactly the same fashion as in the adult patient. In particular, the same size needle-catheter is used for initial decompression.
6. Circulation is initially assessed using capillary refill, peripheral pulses, and temperature and color of the extremities. Circulation is supported with 20 ml/kg boluses of normal saline or Ringer's lactate.
7. Inflation of the abdominal segment of the PASG in a pediatric patient should be avoided unless the child is intubated.
8. Time is critical. Gaining IV access on a pediatric patient can be extremely difficult. Access beyond the first attempt should be pursued en route. An IO line should be considered.
9. Head injury with increased intracranial pressure is the cause of most pediatric trauma mortality. Posturing, unequal pupils, a firm fontanel, a deteriorating mental status or the combination of increased blood pressure and decreased pulse suggest increased intracranial pressure. Increased intracranial pressure is treated with hyperventilation, fluid restriction and head elevation if the child is not in shock. If the child is in shock, fluid boluses are used to improve brain circulation, and hyperventilation is relied on as the sole means of controlling intracranial pressure. Steroids are not used.
10. If a life-threatening injury is found during the ABC assessment, load-and-go is in order after stabilizing the life-threatening injury. No head-to-toe examination is performed.
11. During the head-to-toe examination, it is critical to avoid exposing the child to the point of hypothermia.
12. Liver and spleen injuries are the second leading cause of death in pediatric trauma patients. Abdominal distention or bruising associated with poor circulation suggests one of these injuries. Support of circulation and rapid transport are the keys to caring for these children in the field.
13. Extremity injuries in children may have important effects on long-term growth of the child's musculoskeletal system.
14. Because children are often nonverbal, uncooperative, or have a depressed mental status from head trauma, their assessment is difficult. Determining the mechanism of injury at the scene can assist physicians in uncovering subtle injuries.
15. The management of pediatric trauma at the scene, and particularly during the first 24 hours,

differs greatly from the management of adult trauma. Pediatric trauma patients should be transported to hospitals that are familiar with these differences.

Chapter 9

Burns

OBJECTIVES

1. From a list, select those complications that pediatric victims of burn injury are particularly vulnerable to.

Major burns account for 10 percent of deaths caused by accidental injury in children. There are four significant differences between the field assessment and management of pediatric burn patients and that of adult burn patients.

1. Increased airway vulnerability exists among pediatric burn patients.
2. Pediatric burn patients are more susceptible to carbon monoxide poisoning.
3. Pediatric burn patients have an increased risk of hypothermia.
4. Children have different body-surface proportions than adults, which affects estimation of the extent of the burn.

These four differences will be discussed before overall burn management of pediatric patients in the field setting is summarized.

AIRWAY VULNERABILITY

The airway of the pediatric patient is narrower than the airway of an adult. Inhaled hot air and toxic fumes cause the lining of the pediatric patient's airway to swell to the same degree as the lining of the adult's
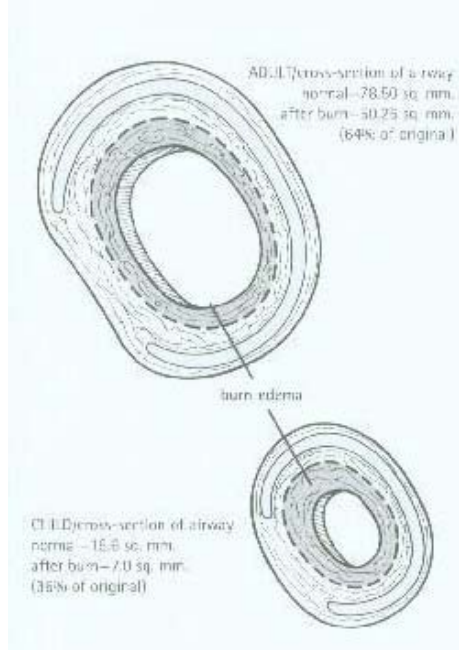

Figure 9-1 Comparison of cross-section of burned adult and pediatric tracheas. A. A rim of edema in the adult trachea reduces the size of the effective tracheal lumen by 20 percent to 30 percent (in this case). B. A similar rim of edema in the pediatric trachea reduces the size of its lumen by over 50%.

airway. Consequently, a rim of swelling within the adult's airway that reduces the airway size by only 10 percent or 15 percent can reduce the size of the pediatric airway by over 50 percent (Figure 9-1). When managing a pediatric burn victim, therefore, the EMT must carefully examine the child for signs that suggest the risk of an airway burn. These signs include facial burns and char or soot in the nares or mouth. A child who has been burned while in an enclosed space is also at risk for an airway burn. Signs that actual airway swelling is present include stridor, brassy cough, hoarseness or labored breathing. Airway swelling can progress rapidly. At a minimum, oxygen should be provided when there is a risk of airway injury. Humidified oxygen is preferable. Intubation should be performed if stridor or respiratory distress is progressive. To use the rule presented in Chapter 3 for determining the need for intubation (apnea, gasping or cyanosis despite oxygen therapy) would be a mistake in the case of a burned child. By the time cyanosis with oxygen has developed, there may be so much airway swelling that

intubation will be extremely difficult, if not impossible. As an example, consider a badly burned child with a depressed level of consciousness who is observed to have facial burns but no stridor or respiratory distress when removed from a burning house. After immobilization on a spine board, removal of burned clothing, covering with clean sheets and application of high concentration oxygen by mask, significant stridor and retractions are noted. Unless transport time is very short, this child should be intubated prior to transport. Choice of an endotracheal tube one or two sizes smaller than would usually be chosen based on the child's age is appropriate. Great care must be used to avoid damage to tissues during intubation. Inhalation injury renders the tissues of the upper airway particularly vulnerable to further damage.

CARBON MONOXIDE POISONING

A pediatric patient is more vulnerable to carbon monoxide poisoning than an adult for one of two reasons, depending on the patient's age. Small infants have large amounts of fetal hemoglobin in their red blood cells which has a high attraction for carbon monoxide. Older infants and small children have lower total hemoglobin levels than adults and are therefore more quickly saturated with carbon monoxide. Consequently, when a child and an adult have the same percentage of carbon monoxide in their bloodstreams (and attached to hemoglobin), the child has less functional hemoglobin available to carry oxygen. Because carbon monoxide is a component of the fumes of most fires, all burn victims, but particularly pediatric burn victims, should receive high-concentration oxygen as soon as possible. (One protective factor for infants and small children is that carbon monoxide rises to the ceiling of an enclosed space, somewhat reducing the exposure of the shorter child compared to that of the taller adult.) Finally, remember that carbon monoxide causes blood to turn red despite a low concentration of oxygen. Consequently, the absence of cyanosis is not a useful indicator for assessing a burn victim's respiratory status. As described above, work of breathing and stridor are the keys.

HYPOTHERMIA

Most burns occur during the winter months. As soon as the child is safely out of the burning area, his burned clothing must be removed. At this point the child is particularly vulnerable to rapid cooling for two reasons. First, the child has a high ratio of surface area to total body mass (Figure 9-2). For example, a 1-year-old child has twice as much surface area per pound of body weight as an adult. On a cold day, twice as much heat is lost to the environment per pound of body weight. Hypothermia will result if adequate precautions are not taken by pre-hospital care personnel. If hypothermia does result, chances for survival are significantly reduced. Second, many burn victims are at increased risk for hypothermia because of the impaired ability of burned areas of skin to retain body heat. Areas of first and second degree burns, in particular, may lose their ability to vasoconstrict blood vessels in response to cold. Hence, warmed blood continues to richly perfuse the burned area, resulting in considerable transfer of heat to the environment.

To protect the pediatric burn victim from hypothermia, EMTs must work quickly, cover the child with clean sheets, and move the child into a warmed vehicle as soon as possible. If an IV line is to be started, for example, it should be done in a warmed vehicle. Keeping the burned child warm is a much greater priority than starting an IV line, as will be discussed below.

ESTIMATING SURFACE AREA BURNED

Infants and small children have proportionally smaller legs and larger heads than adults. The traditional "rule of nines" used on adults to estimate the percentage of body surface burned must be modified for different ages. Rather than memorizing charts for various ages two reference standards that apply to all ages can be used: (1) the palm of one hand comprises approximately 1 percent of total body surface area and (2) the anterior trunk comprises approximately 18 percent of total body surface area, regardless of age. Comparing the size of these two areas to the burned areas will permit the burn size to be quickly categorized and an appropriate receiving facility chosen (see below).

The estimation of total body surface area burned should be conducted after moving the child to a warmed vehicle. Exposing the child to the risk of hypothermia simply to estimate the size of the burn would not be good judgment.

BURN MANAGEMENT

Small burns (less than 10 percent or 15 percent, first degree or second degree) on a child are managed just as on an adult: cool wet sterile compresses for comfort, careful drying while avoiding any trauma (with care not to break the blister), sterile dressings (no ointments), elevation and transport. Cool compresses are not useful for small third degree burns. These burns are not painful. On the other hand, during the transport of a child with small first and second degree burns, cool compresses might be continued for added comfort if the child is cooperative and there is no risk of hypothermia.

For larger burns or burns incurred as a result of flames in an enclosed space, the sequence of management priorities after the child has been removed from the space is as follows:

1. Immobilize cervical spine and remove burned clothes.
2. Perform ABCD (oxygen by mask for all children).
3. Cover with clean sheets.
4. Move to a warmed vehicle.
5. Reassess ABCD; intubate if there is respiratory deterioration.
6. Quickly estimate surface area burned.
7. Start IV line if perfusion status is inadequate.
8. Transport.

Though fluid loss is a major complication of burns—particularly burns because of the large surface-area-to-weight ratio of the pediatric patient—it is not a problem that is likely to complicate the scene management of a pediatric patient. The decision to start an IV line should therefore be based on the child's circulatory status rather than percentage of body surface burned. This is particularly true because an IV line started under field conditions might increase the risk of one of the most feared complications of burns: infection. Unless a burn patient has also suffered blunt or penetrating trauma resulting in blood loss, an IV line at the scene will probably not be needed or advisable.

Which pediatric burn patient should be transported to a burn center rather than a pediatric hospital or the nearest hospital or trauma center? This is not an easy question to answer. Each locality must determine its own answer based on local resources and the commitment of these resources to the care of the pediatric burn patient. Distance and the condition of the child will also obviously play a role in the decision-making. In general, second degree burns of greater than 20 percent body surface area, or third degree burns of greater than 5 percent body surface area or major burns of the hands, feet, face or genital area will require the expertise of a burn center. Burn patients with significant respiratory compromise, but a relatively small percentage of total body surface area burned, need a pediatric intensive care unit, which is most likely to be found at a pediatric hospital. Large burns or burns of the hands, feet, face or genital area that also involve respiratory compromise will generally be best treated at a burn center. Whether other hospitals should be bypassed to take a patient to a pediatric hospital or burn center will depend on factors such as distance and stability of the patient's airway. The important point is that a local protocol should be developed to facilitate the decision-making process at the scene. Burn patients who do not require a pediatric intensive care unit or burn center should be transported to the nearest appropriate hospital for children.

SUMMARY OF KEY POINTS

1. Burned infants and children are vulnerable to airway compromise. All should be treated with humidified oxygen. They should be intubated if respiratory distress is progressive.
2. Burned infants and children are vulnerable to carbon monoxide poisoning. All burned infants and children should be treated with high-concentration humidified oxygen.
3. Infants and children are vulnerable to hypothermia.
4. Infants and small children have proportionately larger heads and smaller legs than older children and adults.
5. Starting an IV line in a pediatric burn victim should not be routine, even when the percentage of total body surface area burned is large.

Chapter 10

Child Abuse

OBJECTIVES

1. From a list identify those things that serve as clues to indicate child abuse.
2. Given a description of a family environment, determine the potential for child abuse.
3. Given a list of statements regarding child abuse and the EMT response to it, identify whether each statement is true or false.

Child abuse presents four challenges to EMS personnel:

1. Recognizing that a child's injuries may be caused by child abuse;
2. Gathering data to assist with the final judgment regarding the possibility of child abuse;
3. Controlling one's emotions, particularly when dealing with a suspected abuser;
4. Guaranteeing that a possible child abuse case is properly reported.

RECOGNITION

Certain observations should alert the EMT to the possibility of child abuse. An underweight, foul-smelling child should be regarded by the EMT as one who may be experiencing neglect.

Injuries that should arouse suspicion of child abuse include the following:
1. Bruises of different ages (red or blue, 0 to 5 days old; green, 5 to 7 days old; brown, 10 to 14 days old);
2. Bruises or burns of uniform size and/or shape: for example, small round burns (cigarette burns) or U-shaped bruises (belt);
3. Injuries to the genital area;
4. Multiple facial bruises;
5. Neglected injuries such as infected burns.

A history that is inconsistent with the nature of the injury, that conflicts with the history given by another adult on the scene, or that is inconsistent with the child's age (for example, a 6-month-old child reported to have "fallen out of his crib") should be regarded with suspicion.

A parent who acts unconcerned about an injured child should be regarded with suspicion, as should a parent who is overly demanding (suggesting guilt). A parent who responds to an injured child's distress by saying, "Be quiet, the medic is only trying to help you," demonstrates a level of intolerance that should arouse suspicion. Very passive or "shell-shocked" behavior on the part of the child should also alert the EMT to the possibility of abuse. It is important to keep in mind that a child will not necessarily appear frightened of his abuser.

DATA GATHERING

When an observation raises the suspicion of child abuse in the EMT's mind, after caring for the child's injuries the next step is to gather more information. It is critical that this is done without "tipping one's hand." If the parent or other adult senses the suspicion of the EMT, that person's cooperation will be lost, preventing the gathering of additional information. This would be unfortunate because an EMT at the scene of an alleged accident has a special opportunity to gather data that might easily be hidden from hospital personnel. For example, the EMT has the opportunity to question certain adults who might not make the trip to the hospital. Also, the EMT can directly observe the scene of the alleged accident to see if the history fits the observed facts and the child's injuries. If the parent's story is that the child fell off his bicycle in the rain but the bicycle is dry, the EMT has made a critical observation that can only be made on the scene at the time of the alleged accident. The EMT can also observe the condition of the home, the appearance of other children, and the reactions of key adults in the child's life when under stress but "on their own turf."

How does an EMT gather key pieces of information without revealing the reason for her questioning? A few techniques are useful in this regard. First, key questions should not be posed immediately after observing the injury or other factors that raise the suspicion of abuse. Instead, these key questions should be delayed and incorporated calmly into a routine battery of questions. For example, after observing a suspicious injury one might ask about allergies, sources of regular medical care, and any recent illnesses or visits to the emergency room. Then specific questions regarding the alleged accident can be posed in a matter-of-fact way. Another technique is to place the responsibility for the EMTs questioning on someone else. For example, "The physician at X hospital requests that we carefully review exactly how an injury occurred to help him uncover nonapparent injuries." One final technique is to pose some questions casually rather than as part of a set of medical history questions. For example, after apparently gathering all needed information and after one EMT has returned to the squad vehicle to use the radio or get a piece of equipment, the remaining EMT might calmly ask about the child's general behavior or previous injuries.

CONTROLLING ONE'S EMOTIONS

One of the most difficult tasks when faced with an obvious child abuse case is controlling one's anger. Nevertheless, one of the obligations that comes with the uniform, whether the uniform of an EMT or the lab coat of the physician, is to be professional at all times. When the uniform is not on, a set of emotional responses, that cannot be displayed in our professional activities, is permissible. As professionals we must view even the presumed abuser as a patient. Furthermore, we need to recognize that an unprofessional show of emotion will not benefit the child. Transport may be refused (although transport can be forced with a call to the police). Furthermore, since most abused children are returned to the same environment in which the abuse occurred, it is critical that the EMT, as the first representative of society and the medical profession to deal with the family, establish a positive relationship with the family. Ideally, this positive relationship will carry over to relationships with other medical and social professionals. Such positive relationships will be one of the keys to protecting the child in the future. The abuser must feel that there is an alternative to venting her frustrations on the child, namely, calling the case worker or the

child's physician and asking for help.

Understanding the source of child abuse helps medical professionals to remain objective and nonjudgmental when dealing with child abuse. Child abuse is usually not a premeditated action. Instead, child abuse occurs when an adult with poor coping mechanisms, faced with many frustrations, experiences one additional frustration. This adult was probably abused as a child. Therefore, this adult responds to mounting frustrations with the same behavior he saw as a child. So the cycle of child abuse continues. Every parent has at some time been pushed by the demanding behavior of an infant or small child to the point where child abuse could occur. However, most parents have methods of coping, many of which they saw their own parents use. They count to 10, hand the child to a spouse, or send the child to his room; but society has not taught all of its members such effective coping mechanisms. Child abuse is one of the results of society's failure to better prepare people to be parents.

REPORTING

It is no secret that physicians are reluctant to report child abuse. It usually involves a confrontation with the family. It frequently involves appearances in court. It is easier to "look the other way," using the justification that one "isn't sure." However, it is not the job of the medical professional to report only certain cases of child abuse, but rather any case in which there is reasonable suspicion. It is the job of social services and the judicial system to make a final determination regarding child abuse. Only aggressive reporting can protect abused children. The child abuse victim who is not reported has no other means of getting society's attention. On the other hand, the family of a falsely reported child abuse case can defend itself in many ways.

Because physicians are sometimes reluctant to report child abuse, it falls squarely on the shoulders of the EMT, who suspects child abuse, to accept some responsibility for reporting the child to the local child protective services agency or police department. This is the law. Furthermore, it is morally right. In most states an EMT or any medical professional who fails to report child abuse may be held criminally negligent. EMTs should familiarize themselves with local legislation in this regard. Finally, precise documentation on the trip report of the facts that raise the suspicion of child abuse is critical to the child's protection. The facts include an objective description of parental actions and verbatim documentation of key statements made by the parents and others.

SUMMARY OF KEY POINTS

1. The EMT must be alert to the first clues of child abuse. These include suspicious injuries, inconsistent histories, neglect and suspicious behavior on the part of the parent or the child.
2. When the possibility of child abuse has come to mind, further questioning must be done carefully. If the abuser or other adult recognizes the EMT's suspicions, cooperation will be lost.
3. Remaining professional when faced with an obvious child abuse case is important for both the acute and long-term care of the child.
4. EMTs are obligated to report suspected child abuse. EMTs must not relinquish this role entirely to the receiving physician. Unfortunately, under-reporting results when EMTs do not follow through on their suspicions with at least a discussion with the physician regarding her plans for reporting.
5. Many abusive parents love their children. However, they have poor self-control, low self-esteem, many frustrations and an image of abusive behavior imbedded deeply in the memories of their own childhood.
6. Accurate documentation is critical to those who will subsequently be defending the child's rights and interests.

Chapter 11

Newborn Resuscitation and Transport

OBJECTIVES

1. Given a list of newborn resuscitative measures and a list of potential complications, match each measure with its most likely complication.
2. From a list of questions, identify those which identify neonates most likely to need resuscitation.
3. Given a list of resuscitative strategies, place them in proper order of priority for resuscitation of both meconium stained and non-meconium stained neonates.
4. From a list of assessment parameters, identify those which indicate that progression of resuscitative efforts is appropriate and how these assessments are done.

Resuscitation and transport of the newborn can present many special problems for pre-hospital care workers. Fortunately, however, most newborns delivered in the pre-hospital setting do not require major resuscitative efforts. Drying, warming, stimulating, and possibly suctioning and providing blow-by oxygen will be all that most infants will require. Furthermore, the likelihood that a major resuscitative effort may be needed can often be anticipated when such factors as breech delivery, prematurity, meconium-stained amniotic fluid, and multiple pregnancy are known to be present. Nevertheless, it pays to always expect that a full resuscitative effort will be needed and to prepare accordingly. Resuscitation of the newborn is one of the few emergency procedures EMTs perform for which there may be time to prepare before the procedure is needed. EMTs should take maximal advantage of this grace period. After the infant is born, a few seconds delay because of inadequate preparation could make a critical difference to the infant's chance for survival.

PREPARATION

Preparation for a newborn resuscitation may be divided into three components: space, equipment and personnel. A space that is well lighted, warm, and equipped with a high table should be prepared. The table should be placed away from drafts and cold exterior walls. The following equipment should be on hand:

For Airway and Ventilation
1. Newborn and premature masks for PPV and small partial rebreathing masks for blow-by oxygen administration.
2. 100 percent oxygen source
3. Self-inflating 500-ml resuscitation bag with a pressure pop-off valve that can be inactivated
4. Suction bulb
5. Suction catheters (No. 5 and No. 8 French)
6. Oral airways (premature and newborn sizes)

7. Laryngoscope with Miller 0 blade
8. Endotracheal (ET) tubes (3.0 mm internal diameter [ID] for premature newborn; 3.5 mm ID for term newborn)

For Circulation
1. Butterfly needles (23 gauge, 25 gauge); angiocaths (22 gauge, 24 gauge)
2. Normal saline (30 ml in a syringe)
3. D1OW(lOml)
4. Epinephrine 1:10,000
5. Three-way stopcock, syringes

For Warming
1. Stockinette
2. Warm packs
3. Many blankets

Other
1. Dextrostix (or Chemstrips)
2. Lancets
3. Cord ties or clamps

Finally, at least two EMTs must be available to perform the initial resuscitation. If there are only two EMTs on the scene, both should attend to the infant for the first few minutes after birth. During this time there is little that needs to be done for the mother. The resuscitators should plan ahead for an orderly division of responsibilities during the resuscitation. For example, one EMT should assume all responsibility for airway and ventilation. The other EMT should be responsible for drying, warming, stimulating, monitoring pulses (by palpating the base of the umbilical cord) and providing cardiac compressions as needed.

HISTORY

While preparing for the infant's resuscitation as described above, three key questions must be asked of the expectant mother:

1. What is the baby's due date?
2. Has there been any passage of green fluid?
3. Is it known if this is a single or multiple pregnancy?

Although many other questions might be asked to assist with the care of the expectant mother, answers to these three questions will be the most important in determining the care of the infant after birth. If labor is occurring more than three (3) weeks before the infant's due date, then (assuming the date to be accurate) the complications of prematurity can be anticipated. If the baby is post-term, meconium staining and hypoglycemia can be anticipated. Post-term infants may also be at high risk for congenital anomalies.

The second question (passage of green fluid) is searching for evidence of meconium staining. The special care required in this particular situation is described later in the chapter.

If the expectant mother indicates the possibility of a. multiple pregnancy, there are several implications. Two resuscitation areas must be prepared. Also, because twins are commonly born prematurely, the complications of prematurity must be anticipated.

Obviously, other questions need to be asked to assist in the care of the mother. Important issues to address include type of prenatal care, duration and spacing of contractions and a history of drug abuse or diabetes. However, in terms of anticipating the needs of the infant during resuscitation, the answers to these questions will not have great immediate impact. In particular, despite common belief, the infant born to a drug-addicted mother is unlikely to experience respiratory depression as a result of the mother's drug abuse. Instead, such an infant will have, as one of his biggest problems, "drug-withdrawal syndrome," occurring several days after the delivery.

EXAMINATION OF THE MOTHER

From the perspective of the infant's resuscitation, the two most important observations to be made, when examining the mother prior to the birth of the baby, concern the infant's position and evidence of meconium staining. Any presentation other than a vertex presentation (head first) increases the risk of hypoxia. In this situation, very prompt establishment of ventilation with 100 percent oxygen may be critical. After delivery, a cord looped around the newborn's neck or a knotted cord also suggest the possibility of hypoxia.

CUTTING THE CORD

Immediately after delivery the infant is held at the level of the mother. Two clamps or ties are applied to the cord approximately 3 and 4 inches from the infant, and the cord is cut between the clamps. Sterile technique should be used. However, if the infant is in need of resuscitation, the highest priority in this situation is speed. In fact, if the infant can be placed at the level of the mother on the same table or stretcher on which the mother is lying, resuscitation of the infant can and should proceed prior to the cutting of the cord. Optimally, however, after quickly cutting the cord, the infant will be moved to the resuscitation area.

NEWBORN RESUSCITATION PROTOCOL

A newborn resuscitation protocol is presented on page 81. Most newborns will respond to two simple but very important maneuvers: positioning and vigorous drying. The infant is positioned on a flat surface in the air-sniffing position. Next, and of great importance, the infant is vigorously dried and warmed. Oxygen by blow-by can be administered if color is dusky. Vigorous drying by rubbing the skin promotes crying and, with it, strong respiratory efforts. Suctioning gently with a bulb syringe to clear the nose and mouth is also appropriate at this point. The nose should be suctioned first with the bulb syringe because newborns are obligate nasal breathers; that is, they only breathe through their mouths when crying. More

Figure 11-1 Positioning of the newborn infant during resuscitation. The infant is placed in the Trendelenburg position. The primary resuscitator is at the infant's head.

vigorous suctioning with a catheter or DeLee suction trap should be reserved for the baby with strong respiratory efforts but poor air exchange and for the baby with. meconium-stained fluid. The latter should be suctioned as early as possible to prevent aspiration of meconiurn into the lung with the first breaths. Ideally, this should occur at the time of delivery of the head and before delivery of the trunk.

The next step after warming, drying and stimulating is to assess the baby's respiratory efforts (normal rate is 40 to 60), muscle tone and pulse (normal rate is 100 to 180). These three parameters along with color and reflex irritability compose the Apgar score (Table 11-1). The Apgar score is a method of determining a newborn's need for additional support. Taking a full Apgar score, however, particularly in the pre-hospital setting, is not always practical. Furthermore, respiratory efforts, pulse, and muscle tone generally yield enough information to determine the need for major interventions.

NEWBORN RESUSCITATION PROTOCOL

1. Hold infant at level of mother.
2. Suction nose and mouth with bulb syringe.
3. Cut and tie cord (leave at least 3 inches).
4. Place infant on a flat surface in the air-sniffing position. Use a jaw-thrust maneuver to open the airway.
5. Dry, warm and vigorously stimulate infant for several minutes if necessary. Suction gently (use a bulb syringe).
   NOTE: Most newborns will not need intervention beyond this point.
6. If dusky but pulse is greater than 100, administer blow-by oxygen and continue stimulation.
7. If pulse is less than 100, respirations are irregular, or muscle tone or color is poor, provide PPV and oxygen.
8. If pulse remains less than 100 despite PPV, intubate.
9. If pulse is less than 60 (or 60-80 and not increasing), administer cardiac compressions and medications. Consider a saline bolus.

If the respirations are irregular, the muscle tone poor, or the pulse is less than 100, 100 percent oxygen and positive pressure ventilation should be started promptly while drying and stimulating continue. Points to remember about positive-pressure ventilation with a bag and mask in a newborn are listed below:

1. Use enough pressure to move the chest, and no more. Because the newborn's lungs are initially collapsed, the first few breaths may need to be delivered with substantial pressure. Occasionally, this may necessitate inactivating the pressure release valve on the bag-mask-valve device. After the

first few breaths, much less pressure may be necessary.

2. Provide inspiration slowly; a slow inspiration (prolonged inspiratory time) is more effective than a quick inspiration.
3. Use 100 percent oxygen initially.
4. Maintain the air-sniffing position.
5. To prevent posterior displacement of the mandible, pull the mandible into the mask rather than pushing the mask down onto the face.

Initially, only a few breaths should be given; then the baby should be observed for improvement in pulse, tone and spontaneous respiratory efforts with blow-by oxygen. (Unnecessary positive-pressure ventilation may only force mucus and meconium into the lung. It will also distend the stomach.) If the infant does not improve, positive-pressure ventilation should be continued and preparations for intubation should be made. If at any time the pulse drops below 60 or if the pulse is between 60 and 80 and is not increasing, cardiac compressions should be started and Epinephrine administered. Cardiac compressions should be performed with the chest encircling technique at a rate of 120 per minute and at a depth of 3/4 of an inch. Epinephrine is administered 0.01 mg/kg of the 1:10,000 solution following establishment of IV access.

TABLE 11-1 APGAR SCORING

Sign	0	1	2
Heart rate	Absent	<100	>100
Respirations	Absent	Slow (<40) or irregular	>40
Muscle tone	Limp	Slow flexion	Vigorous
Reflex irritability*	None	Grimace	Cough/sneeze
Color	Diffusely pale/blue	Centrally pink	Completely pink

* Reflex irritability is tested using the stimulus of a catheter passed through the nose. Patency of the nasal opening can be checked simultaneously.

Venous access can be gained in one of three ways:
1. A butterfly needle in a hand vein or scalp vein.
2. A butterfly needle threaded into a vein in the umbilical cord from the side of the cord.
3. An angiocath threaded end-on into the umbilical cord vein exposed by cutting the cord below the clamp (Figure 11-2). A tie is placed around the cord to stabilize and prevent bleeding around the angiocath and IV extension tubing attached to a stopcock is attached to the angiocath for drug and fluid administration.

The three most common reasons for an infant's failure to respond to positive-pressure ventilation with improvement in heart rate, respiratory rate and muscle tone are the following:
1. Improperly performed positive-pressure ventilation.
2. Severe hypoxia prior to birth.
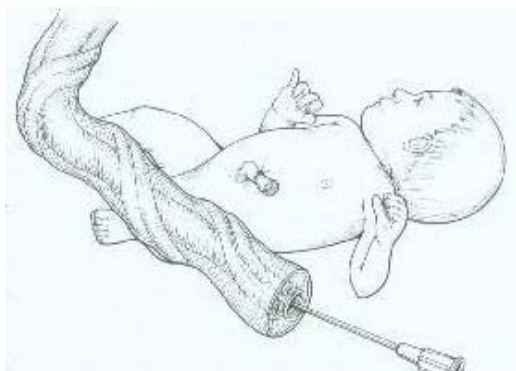3. Blood loss into the placenta before or during birth.

Figure 11-2 Placement of a catheter IV line in an umbilical cord end-on. The cord must be cut within 1 inch of the infant. After the catheter is placed, bleeding from the cord can be controlled by pinching the cord or tying a sterile tie around the cord. A clean tie is acceptable if a sterile tie is not available. (Note that for purposes of illustration only the cord is drawn longer than it will actually be.

Therefore, when an infant is not responding, the first step is to assess chest rise. If there is good chest rise, the next step is to check the strength of the peripheral pulses. If peripheral pulses are palpable, prolonged hypoxia is likely to be the problem. If pulses cannot be palpated, blood loss must be assumed. Blood loss is treated with a bolus of 30 ml of normal saline or Ringer's lactate. If the infant responds to a fluid challenge of 30 ml of normal saline, a second challenge should be considered.

TEMPERATURE REGULATION

Throughout the resuscitative efforts described above, control of the infant's body temperature is both crucial and difficult. The infant loses heat to the environment in several ways. The most important is evaporation of the moisture on the infant's skin at the time of birth. (Imagine how cold it feels to step out of a warm shower without drying.) Therefore, the most critical step in warming the infant is thoroughly drying him. The blankets used for drying should then be replaced with dry blankets or towels, covering as much of the infant as permitted by ongoing efforts at resuscitation. Additional tricks include warming the blankets in a clothes dryer if one is available in the home, superheating the rescue vehicle, and packing the blankets with warming packs, being careful not to allow the hot packs to directly touch the infant's skin. It is critical to remember that hypothermia will significantly decrease the infant's chances for survival. Hypothermia causes acidosis. This worsens the most common breathing problem in the newborn, namely, respiratory distress syndrome (RDS).

AFTER RESUSCITATION: WELL BABY

If the infant has good tone, a lusty cry, good color and heart rate after the resuscitation, he should be wrapped in dry blankets and a head stockinette. The parents should be encouraged to hold the infant. From this point on, the infant should be held on his side to prevent the pooling of fluid in, and consequent obstruction of his posterior airway. The baby's tone, color and respiratory efforts should continue to be monitored. Monitoring is not necessarily an easy task when the baby is swaddled in blankets; therefore, careful observations must be made.

AFTER RESUSCITATION: DISTRESSED BABY

If the infant is not well after the resuscitation, he should be transported promptly with provision of high-concentration oxygen by a mask or positive-pressure ventilation. Strict attention to warming the infant with blankets and other measures should also continue. A monitor should be attached to identify bradycardia, which is the key indicator that additional support is needed. If anticipated transport time is long, a Dextrostix or Chemstrip should be checked before departing. If the Dextrostix finding is less than 60 and an IV line can be quickly placed, 6 ml of D10W should be administered. A continuous infusion of D10W at a rate of 10 ml/hour can then begin. (D10W is made by diluting 2 ml of D50W with 8 ml of sterile water. If sterile water is not available, 8 ml of normal saline may be substituted. Also 1 ml of

D10W infused every 6 minutes is essentially equivalent to a continuous infusion of D10W at l0ml/hour and is much easier to regulate, unless an infusion pump is available.)

SPECIAL SITUATION: PREMATURITY

Premature infants are at special risk for respiratory distress, hypothermia and hypoglycemia. Because infants are born with a blood glucose concentration equal to their mother's blood glucose concentration, hypoglycemia is not likely to occur in any infant immediately after birth. Some time is needed for the glucose level to fall. However, in the premature infant or distressed infant, as described above, the fall in blood glucose may occur rapidly. Hence, rapid transport is one of the priorities when dealing with a premature infant even if the infant appears to be doing well.

The premature infant is at significant risk for hypothermia because of the large surface area-to-weight ratio. The methods discussed above for maintaining body temperature are particularly important for the premature infant. If possible, rectal temperature should be monitored in the baby during transport. (Caution: Insert the thermometer no more than 1/2 inch.)

Respiratory distress syndrome (RDS) develops in premature infants because of immature lungs. Fortunately, for complex reasons, this respiratory distress is not present to its maximal degree at birth. It requires some time to develop. Oxygen or oxygen with positive pressure easily compensates for a premature infant's early respiratory distress in the field. Rapid transport of the premature infant enables the EMT to avoid the need to treat the most severe form of respiratory distress of prematurity.

SPECIAL SITUATION: MECONIUM STAINING

Meconium is the infant's first bowel movement. Passage of meconium prior to delivery raises two concerns. First, this frequently indicates that the infant has been stressed prior to birth by hypoxia, prolonged labor, blood loss, or compression of the umbilical cord. Consequently, the meconium-stained new- born is more likely than other newborns to require resuscitation. Second, the newborn may aspirate meconium into his lungs with his first breaths. This can result in respiratory distress, pneumothorax, pneumonia and even death. The key to preventing meconium aspiration is vigorous suctioning of the meconium-stained infant's pharynx immediately after the head has been delivered. The mother is instructed to stop pushing and begin panting as soon as the head is delivered. A suction catheter (No. 5 or No. 8 French catheter) is used to clear the infant's mouth, pharynx and nose. (NOTE: In this situation the mouth and pharynx, rather than the nose, are suctioned first in order to prevent aspiration of meconium located closest to the vocal cords.) Suctioning to clear meconium is much deeper and more vigorous than routine suctioning of an infant after birth. As a routine, deep suctioning risks bradycardia. It is rarely needed to clear the airway of an infant who is not meconium stained. Therefore, routine suctioning of an infant is conducted with a suction bulb applied to the nose and mouth only. However, in the case of the meconium-stained infant, deep suctioning, including suctioning of the mouth and pharynx, is employed immediately after birth to avoid meconium aspiration. Subsequent suctioning later into the resuscitation is generally limited to nasal suctioning to avoid the risk of bradycardia. An exception to this would be the infant with thick meconium staining. In this situation, if the EMT is skilled at quickly intubating the

infant's trachea, then the trachea should be intubated with a 3.0 mm internal diameter endotracheal tube. Suction is then applied to the tube using an adapter and a portable suction unit set at low to moderate suction. Attempts to perform this maneuver should not extend beyond 30 seconds (or less if the infant becomes bradycardia). Unlike the infant without meconium staining, when meconium staining is present and PPV is needed, suction should be administered first via ET tube prior to ventilating with a bag-valve-mask unit.

SPECIAL SITUATION: APPARENT CONGENITAL MALFORMATIONS

Infants may be born with a great variety of congenital malformations. A few of the more common malformations include cleft lip, myelomeningocele (fluid-filled sac on the newborn's back), and exposed abdominal contents. The management of these malformations in the field may require contact with base station medical control. When dealing with malformations such as myelomeningocele and exposed abdominal contents, the keys to management are moisture, warmth, gentle handling, sterile technique and avoidance of any pressure, tractioning, or twisting of the malformation. To accomplish this, the malformation is covered with sterile 4-by-4 bandages moistened with saline. Sterile roll-gauze is used to hold the bandages in place and give support to the exposed tissues (Figure 11-3). Blankets are then swaddled carefully around the infant. Prompt transport to a hospital with neonatal surgery capabilities is then in order.

SPECIAL CONCERN: OXYGEN TOXICITY

Complications that may result from oxygen administration include:
1. Lung damage
2. Eye damage
3. Hypothermia and apnea (from the rapid flow of cooled oxygen across the infant's face)

Much has been written about the first two complications—so much, in fact, that some infants now receive too little oxygen! The first complication, lung damage, is simply not a concern in the pre-hospital setting.

Figure 11-3 Dressing exposed abdominal contents after birth.

Lung damage results from the prolonged exposure to oxygen (for a period of days), not from the short periods of oxygen therapy that occur in the pre-hospital setting. Eye damage is still a concern. However, the role of oxygen in newborn eye damage has been questioned by recent research. If oxygen does produce eye damage, this complication is known to be limited almost entirely to the premature infant. On the other hand, hypoxia from insufficient administration of oxygen to a premature infant may cause cerebral palsy or mental retardation or may aggravate RDS. On balance, unless a rescue squad carries instruments for measuring blood oxygen saturation via a skin probe and an oxygen-air mixer, it would seem best to administer too much oxygen rather than too little to a premature infant in the pre-

hospital setting. Therefore, if a premature infant is experiencing respiratory distress, cyanosis, or bradycardia, high-concentration oxygen is appropriate along with rapid transport to minimize length of exposure to the high-concentration oxygen.

Hypothermia is probably the most important complication of oxygen administration in the pre-hospital setting. Some keys to avoiding this complication, while not compromising the infant's oxygenation, include the following:

1. Swaddling the infant, including a stockinette over the head, so that the effects of oxygen are limited to the surface area of the infant's face only.
2. Reducing oxygen flow in combination with a tighter mask seal to maintain the same concentration of inspired oxygen (for example, flow may be decreased from the initial 6 liters per minute to 3 liters per minute with an appropriately sized mask and attention to a snug mask-to-face seal. Non-rebreather masks, however, are not efficacious for newborns. Although they do no harm, they probably do not increase the concentration of oxygen delivered over that delivered by a conventional mask.)
3. Counteracting the cooling effects of oxygen, for example, by using warm packs and superheating the rescue vehicle.
4. Rapid transport.

INTER-HOSPITAL TRANSPORT

EMTs are frequently called on to assist with or be entirely responsible for the inter-hospital transport of a newborn infant in distress. EMTs placed in this position should be specially trained in newborn transport. However, this is not always the case. The most important key to the successful inter-hospital transport of a newborn is the stabilization of the infant prior to transport. To determine if an infant is stable for transport, five parameters should be assessed: ph, pO2, temperature, blood pressure and blood glucose. The infant's pH should be normal (7.35 to 7.45) or improving. The pO2 should be between 80 and 100. Temperature should be normal or, if hypothermic, moving toward normal. Mean blood pressure should be greater than 40 (30 for a premature infant) as measured by an ultrasonic technique. Finally, blood glucose concentration should be above 60 and stable as assessed by at least two serial blood glucose measurements separated by at least 30 minutes.

If these five parameters are not stable, communication between the referring and receiving institutions should occur regarding additional stabilizing maneuvers prior to transport. To improve pH, for example, increased ventilation or administration of bicarbonate may be necessary. To improve oxygenation, more pressure, the addition of positive end expiratory pressure (PEEP), or increased oxygen concentration may be needed. A fluid bolus may be needed to improve blood pressure. An increased concentration of IV glucose may be needed to stabilize blood glucose. The point is that it is almost always possible to obtain stability of these five parameters prior to transport. The exception would be in the case of the infant with an unusual congenital malformation, such as congenital heart disease. Therefore, EMTs responsible for transporting a newborn between hospitals should determine if these five parameters have been stabilized prior to transport. If one or more of these parameters is unstable, then the EMT team should seek a good

explanation for the failure to achieve better stabilization before leaving the referring hospital. If orders are given to transport despite apparent lack of stability, it would be prudent to obtain the agreement of specialists at the receiving hospital that transport is judged to be the child's best chance for survival.

SUMMARY OF KEY POINTS

1. Preparation is a key element in newborn resuscitation. Resuscitation space and equipment should be prepared prior to the infant's delivery. The duties of each resuscitator should also be predetermined.
2. At least two rescuers are required to resuscitate a newborn.
3. Key pieces of information that will help EMTs anticipate problems include a history of meconium-stained amniotic fluid, prematurity, postmaturity and multiple pregnancy.
4. Most infants will be successfully resuscitated with proper positioning, vigorous drying and oxygen.
5. The decision to administer positive-pressure ventilation, compressions, or drugs is determined by the infant's heart rate, respiratory efforts and muscle tone.
6. The first positive-pressure breaths administered to a newborn infant may require more pressure than permitted by the resuscitation bag's pressure-release valve.
7. The most likely reason for a newborn's failure to respond to resuscitation is underventilation.
8. Temperature control throughout the resuscitation is critical.
9. Premature infants are at increased risk for respiratory distress, hypothermia and hypoglycemia.
10. A meconium-stained infant must be vigorously suctioned as soon as the head is delivered. These infants are often depressed. They frequently require vigorous resuscitation.
11. The key parameters to assess prior to inter-hospital transport of a newborn are pH, p02, temperature, blood pressure and glucose.

Chapter 12

Choosing a Receiving Facility for a Pediatric Patient

The theme of this text is that "children are different." They are not merely small adults. They require special care in the pre-hospital setting. Similarly, the care children require after arriving at a hospital emergency department differs considerably from adult emergency care. Providing excellent pediatric emergency care requires, above all, a commitment to children. It is not sufficient to have pediatric-sized equipment and a section in the emergency department with teddy bears painted on the walls. The hospital with a true commitment to children accepts the concept that pediatric patients have truly unique needs. This hospital deals with pediatric patients in a manner analogous to the way a trauma center deals with trauma patients. For the trauma patient, the trauma center provides trauma rooms, trauma surgeons, trauma consultants, trauma policies and protocols and a trauma care quality assurance review. The hospital committed to the unique needs of children will provide, to the extent that its resources will allow, separate examining rooms, separate waiting areas, separate nursing staffs, separate consultants, separate policies and procedures, the proper equipment, separate quality assurance reviews and separate continuing education programs devoted to pediatric emergency care.

How does an EMT evaluate an emergency department's commitment to pediatric patients? One approach is to ask area pediatricians which hospitals they refer their patients to for emergency medical evaluation. Another approach is to tour the facility. During the tour, the following questions should be asked:

1. "How do you keep small, sick infants warm?"

The best way to keep a sick infant warm is with a heat shield (radiant warmer). This piece of equipment allows maximum temperature control and maximum access to the infant. An isolette is useless if the infant requires procedures such as gaining IV access, arterial punctures and intubation. A water-flow heating pad is better than nothing. Used with warm blankets and frequent temperature monitoring, it can be made to work.

2. "Do you separate pediatric and adult patients?"

The design and staffing of most emergency departments make the complete separation of pediatric and adult patients extremely difficult. For efficiency, many emergency departments find it more convenient to separate patients by diagnosis (medical or surgical) or severity, rather than by age. Nevertheless, with commitment and a little ingenuity, a great deal of separation between pediatric patients and some of the more frightening sights and sounds of the general emergency department can be achieved. Good designs include separate waiting areas, designated pediatric examination rooms a good distance away from trauma and resuscitation rooms and perhaps separate traffic patterns for pediatric patients and their families. Parenthetically, it is not only the small child who needs to be separated from the bloodied adult with a head laceration, but also the adult angina sufferer who needs to be separated from a crying infant!

3.   "What is your protocol for the management of epiglottitis?"

The most important answer is that the emergency department staff, in fact, has a protocol governing this situation. Optimally, this protocol would include an emphasis on keeping the child calm (no IV lines, no arterial blood gases, no examination of the child's mouth and throat, keeping the child with the parent); consulting appropriate specialists who should be readily available (anesthesiologist, general surgeon, or ear, nose and throat [ENT] surgeon); and making arrangements for rapid access to the operating room where the child is to be intubated or have a tracheostomy tube put in place under controlled conditions. The actual details may vary from one hospital to another. For example, it may be possible to achieve the controlled setting necessary for the child's airway management in the ED's resuscitation room. Also, if the ED'S physicians are particularly skilled at pediatric airway management, they might take the responsibility of establishing an airway for the child with the assistance of an anesthesiologist. The important point is that a hospital with a true commitment to pediatric emergency care will have an epiglottitis management plan that demonstrates an understanding of the priorities and risks involved.

4.   "Whom do you consult for advice when developing a protocol for the management of a specific pediatric emergency situation?"

The question is really whether there is an advocate for children in the emergency department? Has a local pediatrician or group of pediatricians taken a special interest in the emergency department? Is there a member of the emergency physician's group that has a special interest in children? Has a pediatric emergency nurse specialist been designated, much like a trauma nurse specialist, to monitor pediatric care in the emergency department? If the question of a special consultant on policies and procedures for pediatric patients draws blank stares, then the presence of true commitment to children is in doubt.

5.   "Does your hospital have separate intensive care facilities for children or a transfer agreement with a pediatric intensive care unit at another hospital?"

Pediatric emergency patients require emergency care oriented to their special needs. Many emergency departments recognize these special needs and have a commitment to these patients; some emergency departments do not. EMTs should work with their medical directors, directors of local emergency departments and local pediatricians to help ensure that there are appropriate receiving facilities available for the pediatric patients they care for and transport. Furthermore, EMTs need to work with these same groups to develop a community-wide plan that will permit EMTs to transport pediatric patients to the community facilities with the most appropriate emergency care.

SUMMARY OF KEY POINTS

1. The hospital that is committed to children accepts the concept that children are a separate population with truly unique needs.
2. A good way to evaluate an emergency department's commitment to pediatric patients is to ask area pediatricians which hospitals they refer patients to.
3. Another approach to evaluating an emergency department is to tour the facility and ask the following questions:
   a. Does the emergency department warm sick infants with either a Servo-Control heat shield or a water-flow heating pad combined with warm blankets?
   b. Is an effort made to separate pediatric and adult emergency patients?
   c. Is there a plan for managing a child with epiglottitis? Does such a plan include (1) keeping the child calm, (2) consulting readily available specialists, and (3) rapid access to an operating room for intubation or placement of a tracheostomy tube?
   d. Is there an advocate for children or a pediatric specialist in the emergency department?
   e. Is there access to a pediatric intensive care unit for patients in the emergency department?
4. EMTs should work with directors of local emergency departments and local pediatricians to develop a community-wide plan that will permit EMTs to transport children to the most appropriate facilities.

Chapter 13

Risks Associated with the Field Management Pediatric Patients

There are three risks that EMTs face during their daily work: infection, physical trauma and emotional trauma.

INFECTION

From a statistical point of view, EMTs are at less risk for contracting a serious infectious disease from a pediatric patient than from an adult patient, simply because pediatric patients are less likely to carry serious transmissible illnesses such as hepatitis, tuberculosis or AIDS. Of course, statistics offer no protection to the EMT who is caring for an infant or child who happens to harbor a serious infectious disease. Consequently, it would be a mistake to simply "play the odds" and take no precautions when dealing with pediatric patients.

When there is risk of contact with body fluids, wearing gloves is a reasonable precaution. This risk is present when dealing with most infants and with patients requiring intubation, positive-pressure ventilation or IV access. Gloves should be used for all of these procedures. In addition, good daily hand care, which minimizes open sores on one's hands, affords considerable protection in the event that gloves fail to prevent direct contact with body fluids. Routine hand washing after each call is also very important.

More difficult to deal with is the risk of acquiring an infection via airborne droplets from the child's mouth. Infections that are spread in this matter are common in children. They include, but are not limited to: croup, epiglottitis, colds, strep throat, chicken pox, measles, mumps, rubella, whooping cough and meningitis. The box on the next page divides these illnesses into three groups. The first group consists of serious illnesses that may be prevented through proper immunization. All EMTs should consult with their medical directors or their personal physicians regarding the adequacy of their immunization record for the illnesses in this group. For example, the measles vaccine administered during the 1 960s was less effective than the current vaccine. Consequently, EMTs immunized for measles during the 1960s may be at risk of acquiring a variant form of measles termed "atypical measles." Similarly, the rubella vaccine does not protect 100 percent of those who received the immunization. Antibody titers can be checked to determine the adequacy of one's protection against rubella. If titers are low, one should be re-immunized. This is particularly important for women EMTs during childbearing years and any EMT who has frequent contact with a woman of childbearing age.

TRANSMISSIBILITY OF CHILDHOOD INFECTIOUS ILLNESSES

Serious illnesses that may be prevented through proper immunization:
      Measles
      Rubella (German measles)

Mumps
Polio
Diphtheria
Whooping cough
Chicken Pox

Serious illnesses that are not easily transmitted through brief casual contact:
Meningitis
Epiglottitis
Pneumonia
Tuberculosis
AIDS

Illnesses that are relatively easily transmitted with brief contact:
Croup
Upper Respiratory illnesses (colds, influenza)
Strep throat
Bronchiolitis

The second group of illnesses presented in the box includes many serious illnesses that are not easily transmitted as a result of contact with a child harboring one of these illnesses. There is abundant evidence, for example, that health care personnel are not at risk to contract meningitis from a patient with this disease unless mouth-to-mouth resuscitation has been performed or exposure is prolonged (many hours of close contact). This also applies to the possibility of becoming a passive carrier of these infections. Consequently, there is virtually no risk that an EMT might transmit one of these illnesses in this group to members of her family. Pediatric acquired immune deficiency syndrome (AIDS) patients include predominately infants and children born to mothers with AIDS and children who have received multiple blood product infusions, such as children with hemophilia. Pediatric AIDS is also appearing in some sexually abused children. For the EMT the greatest exposure to pediatric AIDS will be during newborn resuscitation. During the entire care of any newborn, the EMT should wear gloves, avoid mouth-to-mouth resuscitation and exercise extreme caution with all needles and other sharp instruments.

The third group of illnesses consists of illnesses that are relatively easily transmitted with brief contact. When contracted by an otherwise healthy adult, these illnesses pose no danger. For instance, croup and bronchiolitis manifest themselves in adults as a cold or laryngitis. However, when passed from an adult to an infant or child there is the potential for more significant illness. EMTs with infants or small children at home should strongly consider wearing masks when dealing with pediatric patients who have the potential for harboring one of these illnesses. This would include all infants and toddlers with fever, cough or sore throat. For EMTs without infants or small children at home, the decision to wear masks should be guided by both personal judgment and the local and regional policies governing EMS activities.

The disadvantage of wearing a mask is that the EMT will be more frightening to the child. This will make management of the child more difficult, particularly for a child who is having respiratory distress. At least

during the initial assessment from across the room, as described in Chapter 3, a mask would not be necessary for protection and would be best reserved for parts of the assessment involving closer contact.

PHYSICAL TRAUMA

Pediatric patients pose far less of a physical threat to EMTs than do adult patients. The same cannot be said for their parents, however. A sick or injured child can make a parent act irrationally, particularly if other factors such as guilt, alcohol or family discord are involved. The EMT must never underestimate the strength of the emotions evoked from such a parent. As for the child, the major physical threat he poses is biting. A human bite, particularly to the hand, is a serious injury. Small children between the ages of 2 and 6 are most likely to employ this method of resistance—often when least expected!

EMOTIONAL TRAUMA

Just as a sick or injured child evokes strong emotions from parents, so, too, are EMTs moved to tears, anger and other strong feelings when dealing with children. Common reasons for the strong feelings evoked by a sick or injured child include parental instincts or identification, perceiving the child as an innocent victim and recognition of the potential for or actual loss of many years of productive life. Discussing each of these factors may help EMTs to understand and deal with their own emotions more effectively.

PARENTAL INSTINCTS

There is no doubt that infants and children evoke protective and nurturing instincts. In fact, studies have shown that an infant's cry alone, independent of other factors, causes a degree of distress in many listeners out of proportion to the decibel level or other characteristics of the sound itself. Health care workers consistently report a heightening of their protective instincts when dealing with a child of approximately the same age as one of their own children. For some health care workers, this phenomenon can impair judgment by interfering with their objectivity.

CHILD AS AN INNOCENT VICTIM

Children are at the mercy of their environments. Perhaps we all are to a greater extent. Nevertheless, one of the barricades that we often use to protect ourselves from confronting the apparent arbitrariness of life's events is to find a reason or explanation for these events. "He was drinking," or "She didn't wear her seat belt," are some of the rationalizations we use to convince ourselves that life will not deal so randomly with us. Such rationalizations do not work as well when dealing with a sick or injured child. The child is seen as the innocent victim of the capriciousness of others or of disease processes.

MANY LOST LIFE-YEARS

The loss of life is always tragic. One mechanism many of us use to protect ourselves from feelings of despair when an adult patient is lost is to console ourselves and others with the many years of good life

the victim had experienced. This method of self-consolation is clearly not much help when confronted with the death of a child.

If the above rationalizations do not work, how does one cope? The answer will vary from one health care worker to another. Of course, one's own personal religious and social beliefs will play an important role. Three methods of coping are almost universal. The first is talking about one's feelings. Talking and listening are still among medicine's greatest therapies. An EMT needs to discuss the tragedies she has encountered with fellow EMTs, with hospital personnel, with the medical director of the EMS unit and with other support personnel. EMS units should make some effort to structure this activity to guarantee that all members of the unit are offered the opportunity to express their feelings. For example, a regular group meeting with a mental health care worker might be one method. Another method might be to regularly schedule meetings with a variety of individuals to discuss particular concerns such as child abuse case management with a social worker, medical management with a physician, forensic case management with a member of the police department. The most common, and in many ways the best method is the daily rap session with fellow EMTs discussing the events of the previous shift ("war stories").

Another coping mechanism is to obtain follow-up information on children taken to a hospital. Follow-up information can be obtained by telephone or by visiting the child in the hospital. (The child would be thrilled!) Fortunately, children recover well. Their medical outcomes are often better than expected when first taken to the emergency department. Seeing happy endings can go a long way toward helping medical professionals deal with some of the tragedies they encounter.

Finally, one can resolve to use the lessons learned from one tragedy to help the next child. A badly injured child abuse victim can bolster one's resolve to ensure that the next case of suspected child abuse is reported. A badly injured, unrestrained child might strengthen one's resolve to campaign for tougher child restraint laws or greater compliance with existing laws.

Few events are as upsetting as dealing with seriously ill or badly injured child. To prevent burnout, depression, and other dysfunctional responses to these upsetting events, EMTs need to consciously confront their feelings in constructive ways and help their partners to do the same.

SUMMARY OF KEY POINTS

1. Three risks that EMTs face in their daily work are infection, physical trauma and emotional trauma.
2. Routine hand washing and the use of gloves minimizes infection when working with infants and patients requiring intubation, positive-pressure ventilation or IV access.
3. Airborne infections are more difficult to avoid and can be divided into three categories: (1) serious illnesses that are preventable through immunization, (2) serious illnesses that are not easily transmitted and (3) easily transmitted illnesses that pose little danger to adults.
4. Easily transmitted illnesses that pose little danger to adults can have serious consequences if passed on to other small children. The EMT should weigh benefits and disadvantages of wearing a mask in such cases.
5. Two major physical threats to an EMT who is approaching a pediatric patient are irrational, anxious parents and a child's bite.
6. The EMT can suffer a variety of strong emotions in treating the pediatric patient. These stem from parental instincts, perceiving the child as an innocent victim and recognition of the potential for or actual loss of years of productive life.
7. The EMT should employ any or all of three coping mechanisms for emotional trauma: sharing her feelings, doing follow-up on children brought to a hospital and using the lessons from one tragedy to help the next child.

Chapter 14

Injury Prevention

OBJECTIVES

1. Define the appropriate terms associated with injury control/prevention.
2. Given a scenario of an unintentional injury, identify prevention strategies that could have been taken in an effort to break the injury process.
3. Justify the statement: "The pre-hospital profession is best designed to impact injury prevention in the environment in which injuries occur."
4. List anatomical as well as developmental differences between the adult and pediatric patients that make the pediatric population more susceptible to injuries.
5. Identify common injury prevention topics that are taught in community outreach programs.

Unintentional injury is the leading cause of death and disability in the United States among persons under the age of 45, and is the fourth leading cause of death in all ages. This chapter will address general terms and definitions associated with injury prevention, the injury process, characteristics that make infants, children, and adolescents more susceptible to injuries and prevention strategies that the EMT can use to educate parents, caregivers, children and the community.

DEFINITIONS

The most commonly misused term in injury prevention is "accident." According to Webster's Twentieth Century Dictionary an accident is defined as "an event that occurs without one's foresight or expectation, that proceeds from an unknown cause, or is an unusual effect of a known cause, and thus unexpected, or that is an unfortunate occurrence or mishap, especially if resulting in injury." The implication of this definition is that an accident is an avoidable event. In fact, many accidental injuries could be prevented. For example, a child who sustains a head injury while riding a bike without a helmet has experienced a preventable injury. Hence, these events are coming to be labeled "unintentional injuries" rather than accidents.

THE INJURY PROCESS

In order to practice or be an advocate for injury prevention, it is essential to understand how an injury occurs and, more importantly, how it can be prevented. The easiest way to explain the injury process might be to use an example of the how disease processes are studied.

Diseases are studied by looking at three different components: the patient, the etiology of the disease and the environment in which a disease occurs. Prevention strategies are aimed at identifying mechanisms that result in a particular disease and changing or reducing these mechanisms thereby breaking the disease process. For example, using cardiac disease, there is a great emphasis placed on reducing risk factors that contribute to the disease process. Increasing exercise (patient), controlling hypertension (the etiology) and

reducing exposure to stress (the environment) increase the likelihood of reducing cardiac disease.

The injury process is studied the same way as with any other disease in that it focuses on the same three components: the host (patient), the agent/etiology (energy that caused the injury) and the environment. In addition to the components identified in the injury/disease process, it is also helpful to examine the phases of an injury. These phases are pre-event, event and post-event. William Haddon, a physician and the father of modern injury control, developed a matrix (called Haddon's Matrix) to further analyze how and when an injury occurred. (Table 14-1)

TABLE 14-1 HADDON'S MATRIX

	Host = child	Agent = swing Playground equipment	Environment = Playground surface and health care responders
Pre – event	Teach playground safety	Place swings ample distance from other activities	Pass community ordinaces that require playground surfaces to meet certain standards
Event	Enforce playground rules	Use swing seats of cloth rather than wood or metal	Inspect surfaces regularly (preferably each time a child plays there)
Post – event	Teach a child how to get help and otherwise respond to personal injury	Consider ease of access to medical assistance at design stage	Teach community first aid

By developing this matrix, not only are there three components that can be analyzed in an effort to prevent injuries, but nine areas that can have an impact in breaking the injury process.

CHARACTERISTICS

Many of the anatomical differences, such as the size of the child's head and the location of the internal organs, are characteristics that not only predispose the child to the event of an injury, but may also influence the severity of the injury. An example that would not only increase the likelihood of an injury event, but also the severity of the injury, is the child's size or stature. Younger children, because they cannot easily reach objects, will often pull an object off of a surface and onto themselves. Not only does this expose the child to an injury from the falling object but, if the object were a pan of boiling water or hot grease, it would also elevate the severity of the injury because of the smaller surface area that would be affected.

Limited mobility, coordination and lower muscle strength may also contribute to occurrence of an injury in the pediatric population, for obvious reasons, and should also be kept in mind by the EMT when addressing injury prevention activities.

Two other anatomical and physiological characteristics that are unique to young children are their limited

ability to judge distances and an immature sense of taste that may allow a child to initially experiment with a toxic substance and to continue to ingest a substance that older children and adults would find unacceptably bitter or sour.

Older children, or adolescents, have a greater behavioral risk for injury. Characteristics of this age group include increased activity in high-impact contact sports, accepting the responsibility of driving a motor vehicle (with little or no experience), the potential for initial experimentation with alcohol and other drugs under the influence of peer pressure and a sense of immortality and invulnerability.

PREVENTION STRATEGIES

Through the development of pre-hospital care in the United States, a great deal of emphasis has been placed on the treatment of patients that have already developed an illness or who have become injured. While treating patients that are acutely and seriously ill or injured is obviously a priority, thinking that it is only the job of the pre-hospital care provider fails to take full advantage of EMS personnel's training and experience.

As mentioned previously in the text, the EMT is the only health professional that has the ability to assess a child's environment by direct observation. Because of this, it is imperative that the EMT, responding to a call where a child is sick or injured, consciously makes an effort (when the situation permits) to assess the environment for injury prevention strategies and to take advantage of a "teaching moment" for the parent, caregiver, or child that may prevent additional injuries, or sometimes an unnecessary death, from occurring.

A community outreach program directed at injury awareness and/or prevention, as well as individual one-on-one education, is the arena in which injury prevention has the best outcomes. Injury prevention will have the greatest effect when focused on injuries that are frequent, severe and for which effective strategies are available. Common injury prevention topics include: emergency phone numbers, motor vehicle injuries, pedestrian injuries, bicycle injuries, submersion/drowning, burns, firearm injuries, poisoning, choosing appropriate toys, sports injuries and injuries from fireworks.

Strategies of injury prevention can be divided into two groups: active and passive. Active strategies require constant vigilance. (Example: place medications out of reach.) Passive strategies are in place even when a child is unsupervised. (Example: medications packaged only in child-proof containers.) Passive strategies are much more successful than active strategies.

ESTABLISHING AN INJURY PREVENTION PROGRAM

When planning an outreach program for the community, there are several things that should be considered before the actual course is conducted. These include: when the program is going to take place, where the program is to be held, how the notification of the program is to be distributed, what type of audience should be selected and how the program should be presented.

The when, where, and how of the program should be well established in advance of the course and should not be changed once it has been advertised. Outreach programs should be centered around audiences that include children as well as adults who are interested in the well being of children. Presentations to churches, civic organizations and parents of expecting newborns are examples of a few groups in which injury prevention would produce best results.

Not only should the type of groups be considered when planning an outreach program, the manner in which the program is presented is a major contributor to the success rate of the program. Keeping the age of the audience in mind, the course should be fun and exciting for all participants and should include the intended information with question and answer periods offered frequently. Some ideas for successful presentations styles include: clown shows, puppet shows, robot shows and bike rodeos.

Bibliography

Altieri, M., et al. *The Pediatric Lifeline: Intraosseous Infusion* in *the Field.* J Emerg Med Serv, 1987; 5:37.

Applebaum, D. Advanced *Pre-hospital Care for Pediatric Emergencies.* Ann Emerg Med 1985; 14:656.

Baker, et al. *Injury* to Children *and Teenagers, State-by-State Childhood Injury Mortality Data.* The John Hopkins Center for Injury Research and Policy, 1996.

Eisenberg, M., Bergner, L. and Hallstrom, A. *Epidemiology of Cardiac Arrest and Resuscitation in Children.* Ann Emerg Med 1983; 12:672

Children's Safety Network at the National Center for Education in Maternal and Child Health, 1994. *Building Safer Communities: State and Local Strategies for Preventing Injury and Violence.* National Center for Education in Maternal and Child Health, Arlington, Vir

Gallagher, 5,5., Finison, K., Guyer, B. and Goodenough, S.H. *The Incidence* of *lnjuries* among 87,000 *Massachusetts Children and Adolescents: Resides of the 1980-81 Statewide Childhood Injury Prevention Surveillance System.* American Journal of Public Health 1984; 74:1340-7.

Gallagher, S. *Injuries in the School Environment: A Resource Packet.* Children's Safety Network, National Injury and Violence Prevention Resource Center, Education Development Center, 1996.

Goldstein, B., Cardenas, N. and McDonald, T. *Emergency Transport of Pediatric Trauma Patients.* Presented at the National Conference on Pediatric Trauma, Boston, 1987.

Grace, I. *The Crico-ventilating Device:* A *Method for Ventilation of Needle Cricothyroidotomy.* Emerg Med Serv 1983; 12:45

Haddon, W *Advances in the Epidemiology of Injuries as a Basis for Public Policy.* Public Health Report 1980; 95:41 1-21

Harvey, J.C. *The Emergency Medical Services* System *Act of 1973.* N Engl J Med 1975; 292:529

Hensinger, R.N., Herzenberg, J.E., Dedrick, D.K. and Phillips, WA. *Potential Hazards of Backboards in Emergency Transport of Children with Neck Injuries.* Pod Emerg Care 1988 (abstr); 4:146

Holbrook, P. *Pre-hospital Care of Critically Ill Children.* Crit Care Med 1980; 8:537

Jacobs, L.M. *Results of Aggressive Roadside Treatment of Pediatric* Trauma *Patients.* Pod Emerg Care 1988 (abstr); 4:63

Lewis, F. *Pre-hospital Intravenous Fluid Therapy: Physiologic Computer* Modeling. J Trauma 1986; 26:804

Lubitz, D.S., Seidel, J.S., Chameides, L. et al. *A Rapid Method for Estimating Weight and Resuscitation Drug Dosages from Length in the Pediatric Age Group.* Ann Emerg Med 1988; 17:576

Lynch, F.P., Rodarte, A. and Wotherspoon, L. *Impact of Pre-hospstal Treatment on Pediatric Trauma Outcome.* Ped Emerg Care 1988 (abstr.); 4:162

Mayer, J. *Emergency Medical Service: Delays, Response Time arid Survival.* Med Care 1979; 17:818

Miller, Ted, Ph.D. Costs *of Injuries in 1991 by Cause.* Children's Safety Network Economics and Insurance Resource Center, 1995.

Ramenofsky, M., Luterman, A. and Curreri, W. EMS *for Pediatrics: Optimum Treatment or Unnecessary Delay?* J Pediatr Surg 1983; 18:498

Ramenofsky, M., Luterman, A. and Quindlen, E. *Maximum Survival in Pediatric Trauma: The Ideal System.* J Trauma 1984; 24:818

Rockwood, C., Mann, C. and Farrington, J.D. History *of Emergency Medical Services in the United States.* J Trauma 1976; 16:299

Seidel, J.S. *Emergency* Medical *Services and the Pediatric Patient:* Are *the Needs Being* Met? *II; Training and Equipping Emergency Medical Services Providers for Pediatric Emergencies.* Pediatrics 1986; 78:808

Seidel, J.S., Hornbein, M. and Yoshiyama, K. *Emergency Medical* Services and *the Pediatric Patient: Are the Needs Being Met?* Pediatrics 1984; 73-769

Smith, J.P., Balazs, I.B. and Hill, A. *Pre-hospital Stabilization of Critically Injured Patients:* A *Failed Concept.* J Trauma 1985; 25:65

Smith, J.P., Keseg, D.P., Manley, L.K. and Standeford, T.S. *Intraosseous Infusions, by Pre-hospital Personnel in Critically Ill Pediatric Patients.* Ann Emerg Med 1988; 1.7-491

Stroup, C. *Intraosseous Infusion: Pre-hospital* Use in *the Critically Ill Pediatric Patient.* J Emerg Med Serv 1987; 5:38

Templeton, J.M., Delgado-Paredes, C., Templeton, J.J. and Fleisher, G. *Experimental Pre-hospital Resuscitation for Hemorrhagic Shock in the Young.* Ped Emerg Care 1988 (abstr); 4:157

The National Committee for Injury Prevention and Control, *Injury Prevention, Meeting the Challenge*. Education Development Center, 1989.

Tsai, A. and Kallsen, 0. *Epidemiology of Pediatric Pre-hospital Care.* Ann Emerg Med 1987; 16-284

U.S. Department of Transportation. *Consensus Statement on the EMS Role in Primary Injury Prevention,* 1996.

Weiss, H. Child and *Adolescent Emergency Visit Data Book.* University of Pittsburgh, Pittsburgh, Pa., 1997.